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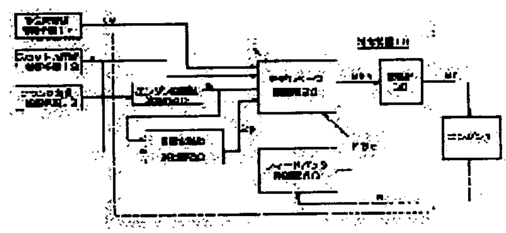
(54) ENGINE CONTROL SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To control an air-fuel ratio without taking uncomfortable feeling to a driver by carrying out feed back controlling an exhaust air-fuel ratio using an air-fuel ratio sensor, and collecting an educator data, only when the educator data of a control logic is collected actually.
SOLUTION: An engine control system is provided with a target air-fuel ratio calculating unit 30 and a feed back control unit 60. In the target air-fuel ratio calculating unit 30, the number of engine revolutions (n) and a throttle opening α are inputted, and a target air-fuel ratio Ep meeting to an operating condition of an engine is decided on the basis of those information, and is outputted to a model base control unit 20. The feed back control unit 60 functions only when a feed back correcting mode is inputted in a control device 10, a signal E outputted from an oxygen sensor is inputted, a feed back correcting signal Fba is decided on the basis of the output signal E, O2 feed back control is carried out, and a learning data is corrected in order to correct the difference between a model base control unit 20 and a real engine 1.



LEGAL STATUS

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CLAIMS

[Claim(s)]
[Claim 1] The engine control system characterized by performing feedback control which feeds back an exhaust air air-fuel ratio using an air-fuel ratio sensor, and gaining the aforementioned teacher data only when gaining the teacher data of the aforementioned control logic substantially, while controlling the air-fuel ratio of an engine by feedforward control logic with a learning function.
[Claim 2] The engine control system according to claim 1 characterized by performing the aforementioned feedback control including the aforementioned control logic.
[Claim 3] The engine control system according to claim 1 or 2 characterized by making feedback gain small and making it an air-fuel ratio not change in step when performing the aforementioned feedback control.
[Claim 4] An engine control system given in any 1 term of the claims 1-3 characterized by performing feedback control according to change of operational status, and gaining teacher data.
[Claim 5] An engine control system given in any 1 term of the claims 1-4 characterized by performing using the reverse model of the engine which constitutes the order model of the engine concerning an air-fuel ratio in the aforementioned control logic, feeds back the virtual air-fuel ratio obtained with this order model, and computes the control input of the operational parameter about the air-fuel ratio of an engine based on this virtual air-fuel ratio and a predetermined target air-fuel ratio.
[Claim 6] The engine control system according to claim 5 characterized by constituting the aforementioned order model using any one of a neural network, a fuzzy neural network, or the CMAC(s).

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the engine control system which controls an air-fuel ratio to a predetermined value.
[0002]
[Description of the Prior Art] In order to reduce unburnt glow gas with strengthening of emission control in recent years, controlling an air-fuel ratio is performed. At the same time it determines basic fuel oil consumption as a control system of said air-fuel ratio based on the operation information on an engine, as shown in drawing 9 While a correction factor is computed so that the occasional operation information may be suited in the correction-factor calculation section from the aforementioned operation information, and carrying out the multiplication of the aforementioned correction factor to the aforementioned basic fuel oil consumption An oxygen sensor is prepared in the exhaust pipe of an engine, and, generally the so-called O2 feedback control which feeds back the output of this oxygen sensor, determines an amendment feedback amendment signal and outputs further the basic fuel oil consumption after the aforementioned amendment in the feedback control section is mentioned. In this O2 feedback control, in order that an oxygen sensor may react only to theoretical air fuel ratio, by maintaining an air-fuel ratio in the state where it changed periodically that it was rich to RIN bordering on theoretical air fuel ratio, as shown in drawing 7 (b), ON/OFF of the oxygen sensor is carried out and the air-fuel ratio is maintained to the predetermined value.
[0003]
[Problem(s) to be Solved by the Invention] However, as described above, in order to use an oxygen sensor, when an air-fuel ratio is periodically fluctuated to RIN as it is rich, as it is shown in drawing 6 (b) and drawing 7 (b), when it also changes torque in connection with it and the air-fuel ratio is always fluctuated like the conventional O2 feedback control, depending on a operating range, it is set to the level which can feel change of this torque, and there is a problem of affecting an operator's feeling. Moreover, the above-mentioned conventional O2 feedback control requires high responsibility, in order to make precision of control high, since fuel oil consumption is determined based on the output of the fed-back oxygen sensor. Therefore, in the conventional O2 feedback control, in order to raise responsibility, feedback gain is enlarged, as shown in drawing 7 (b), the air-fuel ratio is changed in step, and there is also a problem that change of torque becomes large for this reason. this invention aims at offering the engine control system which can perform AFC, without giving an operator an unpleasant feeling, even when solving the trouble of the engine control system using the above-mentioned conventional oxygen sensor and using an oxygen sensor as an air-fuel ratio sensor.
[0004]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, while the engine control system concerning this invention controls the air-fuel ratio of an engine by feedforward control logic with a learning function, only when gaining the teacher data of the aforementioned control logic substantially, it is characterized by performing feedback control which feeds back an exhaust air air-fuel ratio using an air-fuel ratio sensor, and gaining the aforementioned teacher data.
[0005]
[Embodiments of the Invention] Hereafter, with reference to one example shown in the accompanying drawing, the gestalt of operation of the engine control system concerning this invention is explained. Drawing 1 is the schematic diagram showing the relation between an engine 1 and the control unit 10 which can perform the engine control system concerning this invention. An engine 1 introduces a gaseous mixture into the combustion chamber of a cylinder 5 through the air cleaner 3 and fuel injection equipment 4 which were formed in the inlet pipe 2, is a four stroke cycle engine which exhausts the exhaust gas after combustion in the atmosphere through an exhaust pipe 6, and is omitted in

this view about other composition members, such as an inhalation-of-air bulb and an exhaust air bulb. In addition, the sign 7 shows the crank case among drawing 1 , and the sign 8 shows the throttle valve respectively. A control unit 10 operates the fuel oil consumption from a fuel injection equipment 4, and controls the value of the air-fuel ratio in exhaust gas. The information alpha about the throttle opening obtained from the throttle opening detection means 12 prepared in the throttle valve 8 as this control unit 10 is shown in drawing 1 The information r about the crank angle obtained from the crank angle detection means 13 prepared in the crank case 7 The information tw about the inlet-pipe wall temperature obtained from the inlet-pipe wall-temperature detection means 14 prepared in the inlet pipe 2 is inputted. While determining and outputting the control input Mf (namely, fuel oil consumption) of the fuel injection equipment 4 formed in the inlet pipe 2 based on these input The detection signal E about the actual air-fuel ratio obtained from the oxygen sensor 15 prepared in the exhaust pipe 6 is inputted if needed, and it is constituted so that the amendment and study based on this information may be performed and always optimal control can be performed.

[0006] Drawing 2 is the outline block diagram showing the composition of a control unit 10. A control unit 10 A gap of the model-based-control section 20 which determines fuel oil consumption using feedforward control logic along with the target air-fuel ratio Ep, the target air-fuel ratio calculation section 30 which computes the aforementioned target air-fuel ratio Ep, the engine-speed operation part 40, a transducer 50, and the aforementioned model-based-control section 20 to an amendment sake It has the feedback control section 60 which performs feedback control based on the output from an oxygen sensor 15 while performing feedforward control by the model-based-control section 20. It operates by any in feedback amendment mode which perform feedforward control and which perform the aforementioned feedback control while usually performing the control mode or feedforward control they are. The model-based-control section 20 inputs engine-speed n computed by the engine-speed operation part 40 and the throttle opening alpha, the inlet-pipe wall temperature tw, and the target air-fuel ratio Ep computed in the target air-fuel ratio calculation section 30, determines the amount Mfn of basic operation of a fuel injection equipment 4 based on these information, it is a transducer 50, and changes the aforementioned amount Mfn of basic operation into the fuel-injection cycle of an engine 1, and outputs it from a control unit 10 as a control input Mf. The target air-fuel ratio calculation section 30 inputs engine-speed n and the throttle opening alpha, determines the target air-fuel ratio Ep suitable for the operational status of the occasional engine based on these information, and outputs it to the model-based-control section 20. The feedback control section 60 performs O2 feedback control which functions only when put into a control unit 10 by feedback amendment mode, inputs the output signal E from an oxygen sensor 15, determines the feedback amendment signal FBa based on the aforementioned output signal E, and is outputted to the model-based-control section 20, and gains the study data of an amendment sake for the gap with the model-based-control section 20 and the actual engine 1.

[0007] (model-based-control section) With reference to drawing 3 - drawing 5 , the composition of the model-based-control section 20 is explained hereafter. Drawing 3 is the outline block diagram showing the composition of the model-based-control section 20 in drawing 2 . The model-based-control section 20 is equipped with the presumed air-fuel ratio operation part 23 which computes the presumed air-fuel ratio Ev based on the presumed air content Av and the presumed fuel quantity Fv which are outputted from the order model 21 of an air system which modeled the behavior of the air in an inlet pipe 2, the order model 22 of a fuel system which modeled the behavior of the fuel injected from a fuel injection equipment 4, and each order models 21 and 22. Moreover, the model-based-control section 20 is equipped with the feedback loop which feeds back the presumed air-fuel ratio Ev outputted from the presumed air-fuel ratio operation part 23 to the amount operation part 24 of basic operation. The aforementioned amount operation part 24 of basic operation computes the amount Mfn (basic fuel oil consumption) of basic operation to the fuel injection equipment 4 of an engine 1 by inputting the presumed air-fuel ratio Ev outputted from the presumed air-fuel ratio operation part 23, and the target air-fuel ratio Ep outputted from the target air-fuel ratio calculation section 30. This amount Mfn of basic operation is inputted also into the order model 22 of a fuel system while it is outputted from the model-based-control section 20, and the order model 22 of a fuel system calculates the presumed fuel quantity Fv based on the aforementioned amount Mfn of basic operation. As described above, the reverse model of the engine which feeds back the presumed air-fuel ratio Ev outputted from the order model of the aforementioned engine 1 using the feedback loop which constitutes the order model of an engine 1 by the order model 21 of an air system, the order model 22 of a fuel system, and the presumed air-fuel ratio operation part 23, and contains the aforementioned order model 22 of a fuel system, the presumed air-fuel ratio operation part 23, and the amount operation part 24 of basic operation, and outputs the amount Mfn of basic operation consists of the

[0008] (the order model of a fuel system) Drawing 4 is the outline block diagram showing the composition of the aforementioned order model 22 of a fuel system. This order model 22 of a fuel system models the behavior of the fuel injected from the fuel injection equipment 4 as mentioned above. This order model 22 of a fuel system is equipped with non-adhering fuel operation part 22a, adhesion fuel operation part 22b, the first-order-lag sections 22c and 22d,

fuel deposit-efficiency presumption section 22e, and 22f of evaporation time constant presumption sections, and presumes the fuel quantity which actually enters in a cylinder 8 from the amount Mfn (basic fuel oil consumption) of basic operation inputted from the aforementioned amount operation part 24 of basic operation. The aforementioned fuel deposit-efficiency presumption section 22e models the fuel deposit efficiency x using the fuzzy neural network which made the relation between engine-speed n, and the throttle opening alpha and the fuel deposit efficiency x learn beforehand, a neural network, or CMAC, inputs engine-speed n and the throttle opening alpha, and presumes the rate x (henceforth, fuel deposit efficiency x) at which the fuel injected from the fuel injection equipment 4 adheres to the wall surface of inlet-pipe 2 grade based on these information. In addition, although not illustrated, if needed, this fuel deposit-efficiency presumption section 22e inputs the teacher data based on the comparison result of an actual air-fuel ratio and the target air-fuel ratio Ep, when the operational status of an engine is in a transient, and it may be constituted so that the error of the order model of a fuel system which aging etc. produces owing to can be amended and learned. The 22f of the aforementioned evaporation time constant presumption sections Moreover, engine-speed n, throttle opening alpha And the fuzzy neural network which made the relation between the inlet-pipe wall temperature tw (or engine water temperature) and the evaporation time constant tau learn beforehand, The evaporation time constant tau is modeled using a neural network or CMAC. Engine-speed n, the throttle opening alpha, and the inlet-pipe wall temperature tw (or engine water temperature) are inputted, and the time constant tau (henceforth, evaporation time constant tau) in which the fuel adhering to the wall surface evaporates is presumed based on these information. In addition, like the aforementioned fuel deposit-efficiency presumption section 22e, although no less than 22f of this evaporation time constant presumption section is not illustrating, if needed, when the operational status of an engine is in a transient, the teacher data based on the comparison result of an actual air-fuel ratio and the target air-fuel ratio Ep are inputted, and it may be constituted so that the error of the order model of a fuel system which aging etc. produces owing to can be amended and learned. About above-mentioned fuel deposit-efficiency presumption section 22e and 22 above-mentionedf of evaporation time constant presumption sections, it is indicated in detail by Japanese Patent Application No. No. 271188 [eight to] for which the applicant for this patent applied on October 14, Heisei 8. Non-adhering fuel operation part 22a computes the fuel quantity which goes into the combustion chamber of the direct cylinder 5 from the fuel injection equipment 4 in the amount Mfn (namely, basic fuel oil consumption) of basic operation inputted from the amount operation part 24 of basic operation based on the fuel deposit efficiency x obtained from aforementioned fuel deposit-efficiency presumption section 22e. Once adhesion fuel operation part 22b adheres to a wall surface in the amount Mfn (basic fuel oil consumption) of basic operation inputted from the amount operation part 24 of basic operation based on the fuel deposit efficiency x obtained from aforementioned fuel deposit-efficiency presumption section 22e, it computes the fuel quantity which enters in a cylinder 5. The fuel quantity obtained from aforementioned non-adhering fuel operation part 22a and adhesion fuel operation part 22b is the first-order-lag sections 22c and 22d respectively, after approximating in a first order lag based on the evaporation time constants tau1 and tau2 obtained from 22f of evaporation time constant operation part, is added and is outputted from the order model 22 of a fuel system as presumed fuel quantity Fv. In addition, when it usually models the behavior of the fuel injected from the fuel injection equipment 4 in an engine 1, a dead time until injection fuel enters in a cylinder 5 from a fuel injection equipment 4 is taken into consideration. Although it is necessary in drawing 4 to prepare 22g of phase lag sections for dead times which delay a phase by the dead time as a dashed line shows In the order model 22 of a fuel system in this example, the need of preparing 22g of phase lag sections for dead times by advancing the phase of the order model of a fuel system by the aforementioned dead time is abolished. Thereby, since the order model 22 of a fuel system becomes a simple first order lag, when performing feedback control using the output of the order model 22 of a fuel system, it becomes possible to enlarge feedback gain and the exact reverse model with which the proper amount of basic operation is obtained by the transient is constituted.

[0009] (the order model of an air system) Drawing 5 is the outline block diagram showing the composition of the aforementioned order model 21 of an air system. This order model 21 of an air system is equipped with phase-lead-lag-network section 21for throttle opening a, air-content operation part 21b, pressure transducer 21c, 21d of depression-at-engine-manifold operation part, volumetric-efficiency presumption section 21e, and 21f of phase-lead-lag-network sections for engine speeds.

[0010] (Gentlemen phase lead sections 21a and 21f) Aforementioned phase-lead-lag-network section 21for throttle opening a and 21f of phase-lead-lag-network sections for engine speeds advance the phase of the throttle opening alpha inputted by the removed dead time (namely, time after injection fuel is injected from a fuel injection equipment 4, until it enters in a cylinder 5), and engine-speed n in the aforementioned order model 22 of a fuel system. Specifically, the Gentlemen phase lead sections 21a and 21f are respectively equipped with the neural network which learned beforehand the change pattern of the engine speed to time, or throttle opening, and advance a phase by this neural network by calculating the future value of an engine speed or throttle opening based on two or more past engine speeds

or throttle opening in time. Thus, in the order model 21 of an air system, by advancing the phase of throttle opening and an engine speed by the dead time, the phase of both the order model 22 of a fuel system and the order model 21 of an air system will be advanced by the dead time, the phase shift of the presumed fuel quantity Fv and the presumed air content Av is lost by having removed the dead time with the order model 22 of a fuel system, and it becomes possible to presume a proper presumed air-fuel ratio by the presumed air-fuel ratio operation part 23. Moreover, like the engine of a cylinder-injection-of-fuel formula, although it is so small that that in which a dead time until injection fuel enters in a cylinder from a fuel injection equipment does not exist, and the aforementioned dead time can be disregarded, since it is not necessary in a case to prepare the phase lag section for dead times from the start when the behavior of injection fuel is modeled, it is not necessary to, also form the Gentlemen phase lead sections 21a and 21f in the order model 21 of an air system for example. In addition, how to advance a Gentlemen phase is not restricted to the method of using a neural network, but is good by arbitrary methods, for example, may use the least square method etc.

[0011] 21d of modelings by operation part 21b of an air content Av and depression at engine manifold Pman, the hydrodynamic formula (1), and (2) is performed.

空気量 $Av(\alpha, Pman)$

$$= Ct\frac{\pi}{4}D^2\frac{Pamb\sqrt{k}}{\sqrt{RTamb}}\beta_1(\alpha)\beta_2(Pmam)+\dot{m}ao \cdots (1)$$

吸気負圧 $$\dot{P}mam = -\frac{1}{\tau}Pmam\frac{RTmam}{V}Av(\alpha, Pmam) \cdots (2)$$

here -- Ct -- the number of flowmeters in a throttle, and D -- the diameter of a throttle, and Pamb -- atmospheric pressure and k -- the specific heat of air, and Tamb -- large atmospheric temperature and R -- a gas constant and Mao -- amendment -- counting to which inlet-pipe temperature and V depend on inlet-pipe volume, and counting and Tman depend for beta 1 on throttle opening, and beta 2 are counting depending on the pressure-of-induction-pipe force Moreover, about volumetric efficiency eta, modeling by the fuzzy neural networks (or a neural network, CMAC, etc.) where modeling with a formula made the relation between engine speed signal n and the throttle opening alpha, and volumetric efficiency eta, as for eye a difficult hatchet and volumetric-efficiency presumption section 21e, learn beforehand is performed. In addition, when the output from volumetric-efficiency presumption section 21e has a control unit 10 in feedback amendment mode, it is amended by the feedback amendment signal FBa from the aforementioned feedback control section 30, and volumetric-efficiency presumption section 21e is constituted possible [study] by using volumetric efficiency eta after amendment as teacher data.

[0012] (target air-fuel ratio calculation section 30) The target air-fuel ratio calculation section 30 inputs the throttle opening alpha and engine-speed n, determines the optimal target air-fuel ratio each time based on these information, and outputs it to the model-based-control section 20.

[0013] (feedback control section 60) Next, the feedback amendment mode using the feedback control section 60 is explained. The above-mentioned control unit 10 changes from the usual control to feedback amendment mode, when the operational status of an engine changes more than predetermined (for example, when throttle opening changes above predetermined rate of change), as shown in drawing 6 (a). Performing O2 feedback control based on the output signal E of an oxygen sensor 15, while this feedback amendment mode performs feedforward control which maintained desired value uniformly by the model-based-control section 20, it is the mode for gaining the teacher data of an amendment sake for the gap between the order model of the engine in the model-based-control section 20, and an actual engine, and the target air-fuel ratio calculation section 30 maintains the target air-fuel ratio Ep to theoretical air fuel ratio among this mode. Specifically the feedback control section 60 As it feeds back as an output signal E of the oxygen sensor 15 in which the information about the actual air-fuel ratio of the engine 1 controlled by feedforward control logic by making theoretical air fuel ratio into desired value Ep by the model-based-control section 20 was prepared by the exhaust pipe 6 and shown in drawing 7 So that fuel oil consumption may decrease, when the aforementioned output signal is "1" (i.e., when an air-fuel ratio is rich) Moreover, when the aforementioned output signal is "0" (i.e., when an air-fuel ratio is RIN), the amendment feedback amendment signal FBa is determined and the output of the order model of the model-based-control section 20 is outputted so that fuel oil consumption may increase. Specifically, the feedback amendment signal FBa outputted from the aforementioned feedback control section 60 is inputted into the order model 21 of an air system, as it is an amendment thing and the volumetric efficiency eta outputted from volumetric-efficiency presumption section 21e in the order model 21 of an air system of the model-based-control section 20 is shown in drawing 3 , and as shown in drawing 5 , it is added to an output as correction value from volumetric-efficiency presumption section 21e. It is performed until teacher data which become within limits which can permit the gap between the model-based-control section 20 and the actual engine 1 are gained (i.e., as

the output FBa (or output Mfn of the model-based-control section 20) of the feedback control section 60 shows drawing 6 (a) and drawing 7 (a) until this feedback amendment mode begins to vibrate periodically that it is rich to RIN on both sides of theoretical air fuel ratio), and a control unit 10 is usually switched to the control mode after that. The order model 21 of an air system gains the volumetric efficiency eta after the amendment obtained by feedback amendment mode as teacher data, and learns based on this teacher data. Thereby, after study becomes within limits which can permit the gap between the order model of an engine, and an actual engine. In addition, since control based on [in the control unit 10 / inside / of the aforementioned feedback amendment mode] feedforward control logic by the model-based-control section 20 is performed, it is not necessary to think responsibility as important for O2 feedback control in this feedback amendment mode. Therefore, with this control unit 10, as shown in drawing 7 (a), when the output from an oxygen sensor 15 is RIN when the output from an oxygen sensor 15 is rich so that fuel oil consumption may be reduced gradually and so that feedback gain of the aforementioned feedback control section 60 can be made small and fuel oil consumption may not change in step into feedback amendment mode namely, it can be determined that the amendment signal FBa will increase fuel oil consumption gradually.

[0014] (Another example) Drawing 8 shows the outline block diagram of a control unit which can perform another example of the engine control system concerning this invention. In addition, the explanation which overlaps since the relation of the I/O information on a control unit and engine concerning this example and the relation between the output of an oxygen sensor and a feedback amendment signal are the same as the first example shown in drawing 1 - drawing 7 is omitted. This control unit is equipped with the map control section 110 and the feedback control section 130, and operates by any in feedback amendment mode which perform feedforward control by the map control section 110 and which perform feedback control based on the output signal E from an oxygen sensor while usually performing the control mode or the aforementioned feedforward control they are. The map control section 110 calculates the amount Mfn of basic operation from which the optimal fuel oil consumption is beforehand obtained to various engine-speed n and the throttle opening alpha by experiment etc., is what map-ized the result, inputs engine-speed n and the throttle opening alpha, and outputs the optimal amount Mfn of basic operation suitable for those conditions. if this map control section 110 is the composition that feedforward control which can be learned can be performed -- arbitrary composition -- **** -- for example, the map of CMAC etc. which can be learned -- you may constitute -- moreover, the output from a usual map and a usual map -- an amendment -- you may constitute from the amendment section which can do things and which can be learned A control unit 10 changes from the usual control to feedback amendment mode, when the operational status of an engine changes more than predetermined (for example, when throttle opening changes above predetermined rate of change) (refer to drawing 6 (a)). Feedback amendment mode performs O2 feedback control based on the output signal E of an oxygen sensor, it is the mode for gaining the teacher data of an amendment sake for the gap between the map data in the map control section 110, and an actual engine, and the map control section 110 determines that the amount Mfn of basic operation will maintain an air-fuel ratio to theoretical air fuel ratio among this mode. The feedback control section 130 is fed back as an output signal E of the oxygen sensor in which the information about the actual air-fuel ratio of the engine 1 controlled to maintain theoretical air fuel ratio by the map control section 110 was prepared by the exhaust pipe. So that fuel oil consumption may decrease, when the aforementioned output signal is "1" (i.e., when an air-fuel ratio is rich) Moreover, when the aforementioned output signal is "0" (i.e., when an air-fuel ratio is RIN), the amendment feedback amendment signal FBa is determined and the amount Mfn of basic operation from the map control section 110 is outputted so that fuel oil consumption may increase (refer to drawing 7 (a)). The aforementioned feedback amendment signal FBa is added to the amount Mfn of basic operation outputted from the map control section 110, consequently the fuel injection equipment of an engine is operated by the inside of feedback amendment mode with the control input Mf which added the feedforward amendment signal FBa to the amount Mfn of basic operation. It is performed until teacher data which become within limits which can permit the gap between the map data in the map control section 110 and the actual engine 1 are gained (i.e., as the control input Mf showed drawing 6 (a) until this feedback amendment mode begins to vibrate periodically that it is rich to RIN on both sides of theoretical air fuel ratio), and a control unit is usually switched to the control mode after that. The map control section 110 gains the control input Mf after the amendment obtained by feedback amendment mode as teacher data, and learns by making it correspond to engine-speed [at that time] n, and the throttle opening alpha based on this teacher data. Thereby, after study becomes within limits which can permit the gap between the map data of the map control section 110, and an actual engine. In addition, since feedforward control according [a control unit] to the map control section 110 also in the inside of the aforementioned feedback amendment mode is performed, it is not necessary to think responsibility as important like the first example for O2 feedback control in this feedback amendment mode. Therefore, in the control unit of this example as well as the control unit 10 of the first example, as shown in drawing 7 (a) So that feedback gain of the aforementioned feedback control section 130 can be made small and fuel oil consumption may not change in step into feedback amendment

mode That is, when the output from an oxygen sensor is RIN when the output signal from an oxygen sensor is rich so that fuel oil consumption may be reduced gradually and, it can be determined that the amendment signal FBa will increase fuel oil consumption gradually.

[0015] (The example effect) The control unit of the first explained above and the second example Usually, it controls by the model-based-control section 20 (or map control section 110). The gap with the order model (or map data in the map control section 110) of the engine in the aforementioned model-based-control section 20, and an actual engine in order to gain the study data of an amendment sake Usually, since it switches to feedback amendment mode from the control mode, and O2 feedback control is performed, and after study data capture is constituted so that it may usually switch to the control mode It becomes unnecessary to always perform O2 feedback control like the conventional control method, and the effect that the torque change by change of the air-fuel ratio at the time of O2 feedback control can be suppressed in a short time is done so. Moreover, since the control unit of this example is constituted so that study data may be gained according to change of the operational status of an engine, it does so the effect of it becoming unnecessary to perform O2 feedback control by the same operational status for a long time. Furthermore, the control unit of this example usually performs control using feedforward control logic. Moreover, the inside of feedback amendment mode also determines the amount of basic operation using the model-based-control section 20 (or map control section 110) based on feedforward control logic. Since O2 feedback control has gone to the well of study data capture Since it becomes unnecessary not to make responsibility of O2 feedback control high, therefore to be able to make feedback gain small, and to change an air-fuel ratio in step The effect that change of the torque by becoming possible to suppress change of the air-fuel ratio under O2 feedback control to minimum, consequently performing O2 feedback control can also be suppressed to minimum is done so.

[0016] (others -- example of application) in this example explained above, although the second example ******** is maintaining theoretical air fuel ratio for the output of the map control section 110 by the inside of feedback amendment mode maintaining a target air-fuel ratio to theoretical air fuel ratio in the first example What is necessary is just to maintain this to the air-fuel ratio doubled with the reaction value of the air-fuel ratio sensor to be used, when using air-fuel ratio sensors other than an oxygen sensor as a sensor which detects an air-fuel ratio, without being limited to this example. Moreover, in this example, although feedback correction value is determined in the feedback control section 60 in feedback amendment mode based on the output from an oxygen sensor, without being limited to this example, this may input a target air-fuel ratio, the amount of basic operation, and the output from an oxygen sensor, and may determine feedback correction value based on those differences, for example. Furthermore, although the change in feedback amendment mode from the control mode is usually performed in this example based on the rate of change of throttle opening The timing of a change in feedback amendment mode, without being limited to this example For example, you may switch for every predetermined time and may switch based on the rate of change of an engine speed. Various operation modes, such as an idling state and a heavy load quantity rotation state, are decided beforehand, and you may switch based on change of the aforementioned operation mode, and may make it switch compulsorily with the directions from the outside. Moreover, in this example, although the feedback gain of the feedback control section 60 is suppressed small, without being limited to this example, the size of the feedback gain in feedback amendment mode may be changed in step like before, for example, and may be changed according to the operational status of an engine, an operator's feeling, or gong kinky thread nature.

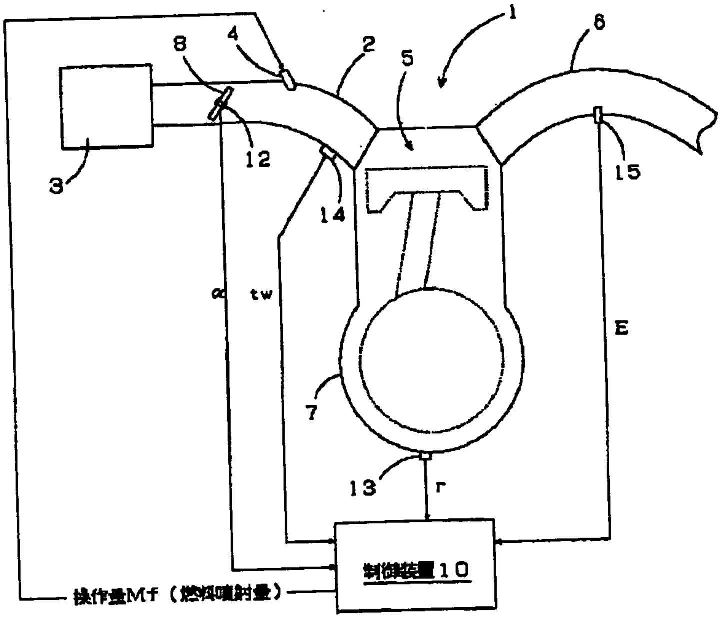
[0017]

[Effect of the Invention] While controlling the air-fuel ratio of an engine by feedforward control logic with a learning function according to the engine control system concerning this invention explained above Since the teacher data of the aforementioned feedforward control with a learning function are gained by performing feedback control which fed back the exhaust air air-fuel ratio using the air-fuel ratio sensor, and includes the aforementioned feedforward control logic with a learning function, for example Even when an oxygen sensor is used as an air-fuel ratio sensor, it is not necessary to always fluctuate an air-fuel ratio like the conventional O2 feedback control. Therefore, it is the the best for the two-wheel barrow by which the effect that an air-fuel ratio is controllable in the optimal state is done so, without giving an operator an unpleasant feeling, and air-fuel ratio change tends [especially] to appear as gong kinky thread aggravation of a driver.

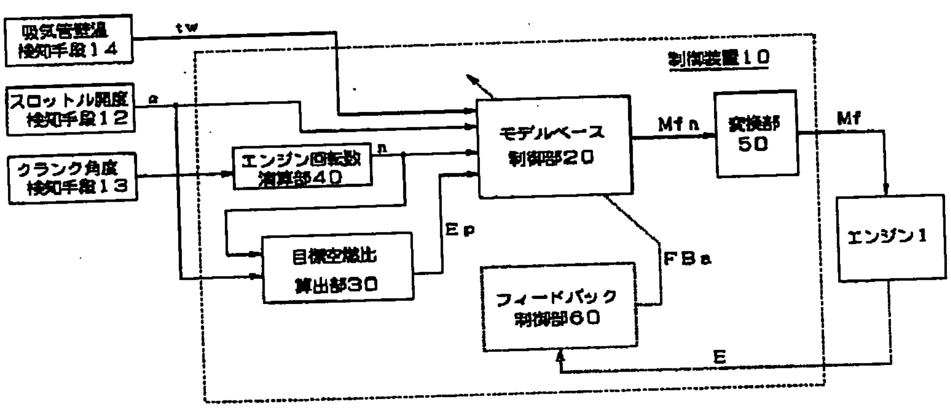
[Translation done.]

DRAWINGS

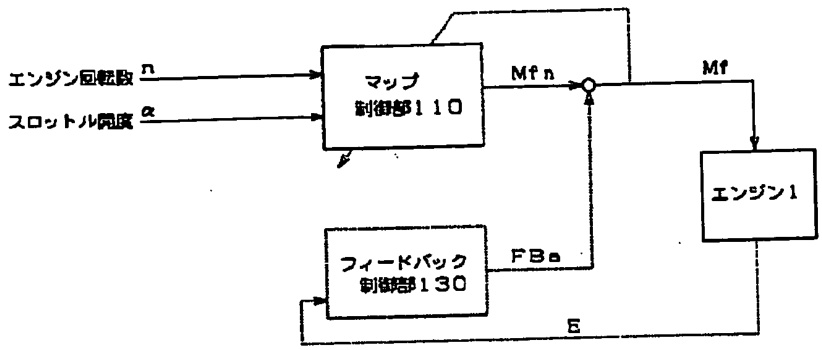
[Drawing 1]



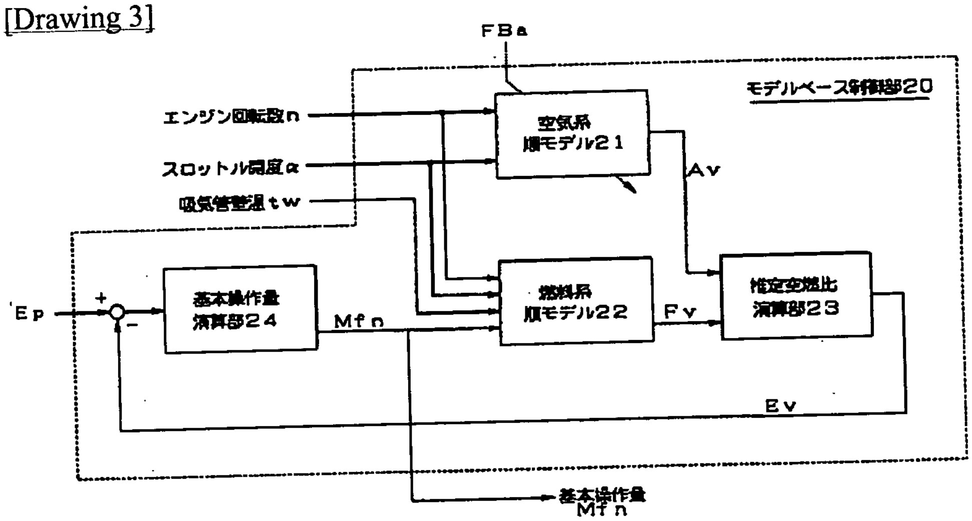
[Drawing 2]



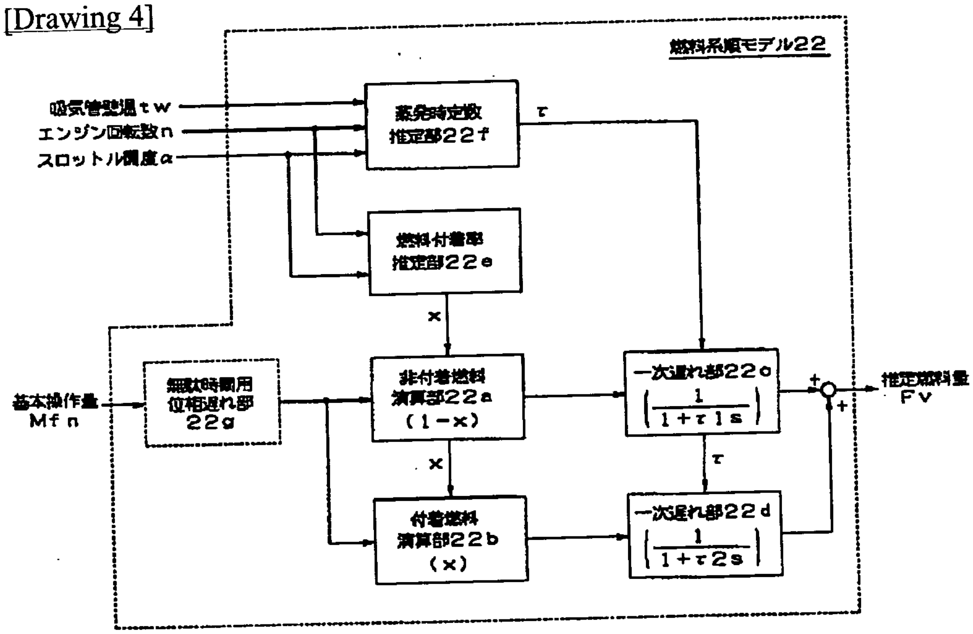
[Drawing 8]



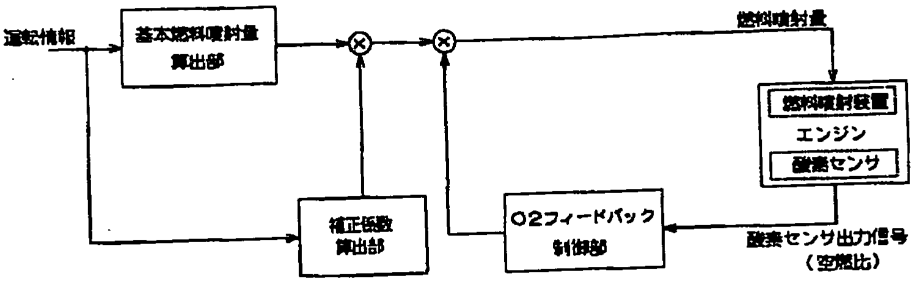
[Drawing 3]



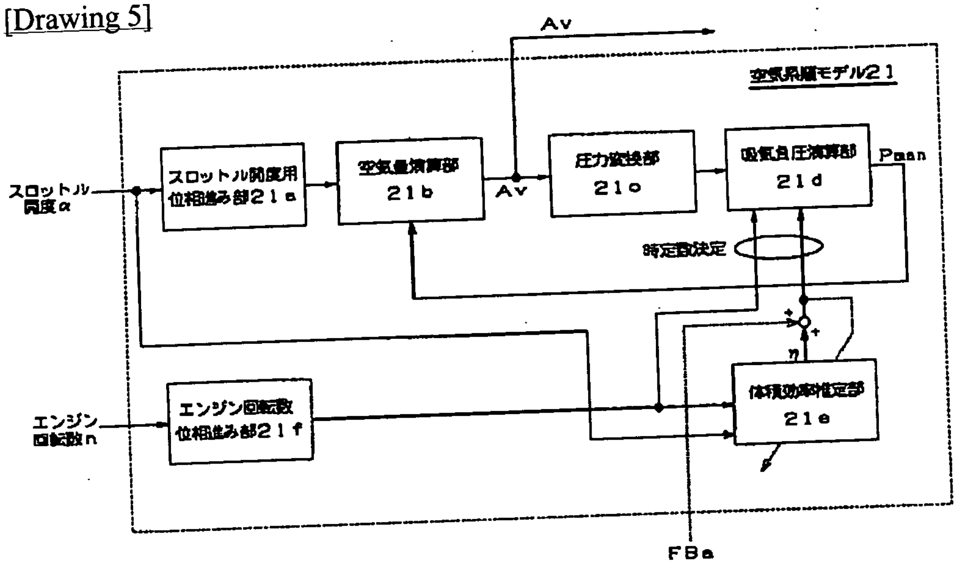
[Drawing 4]



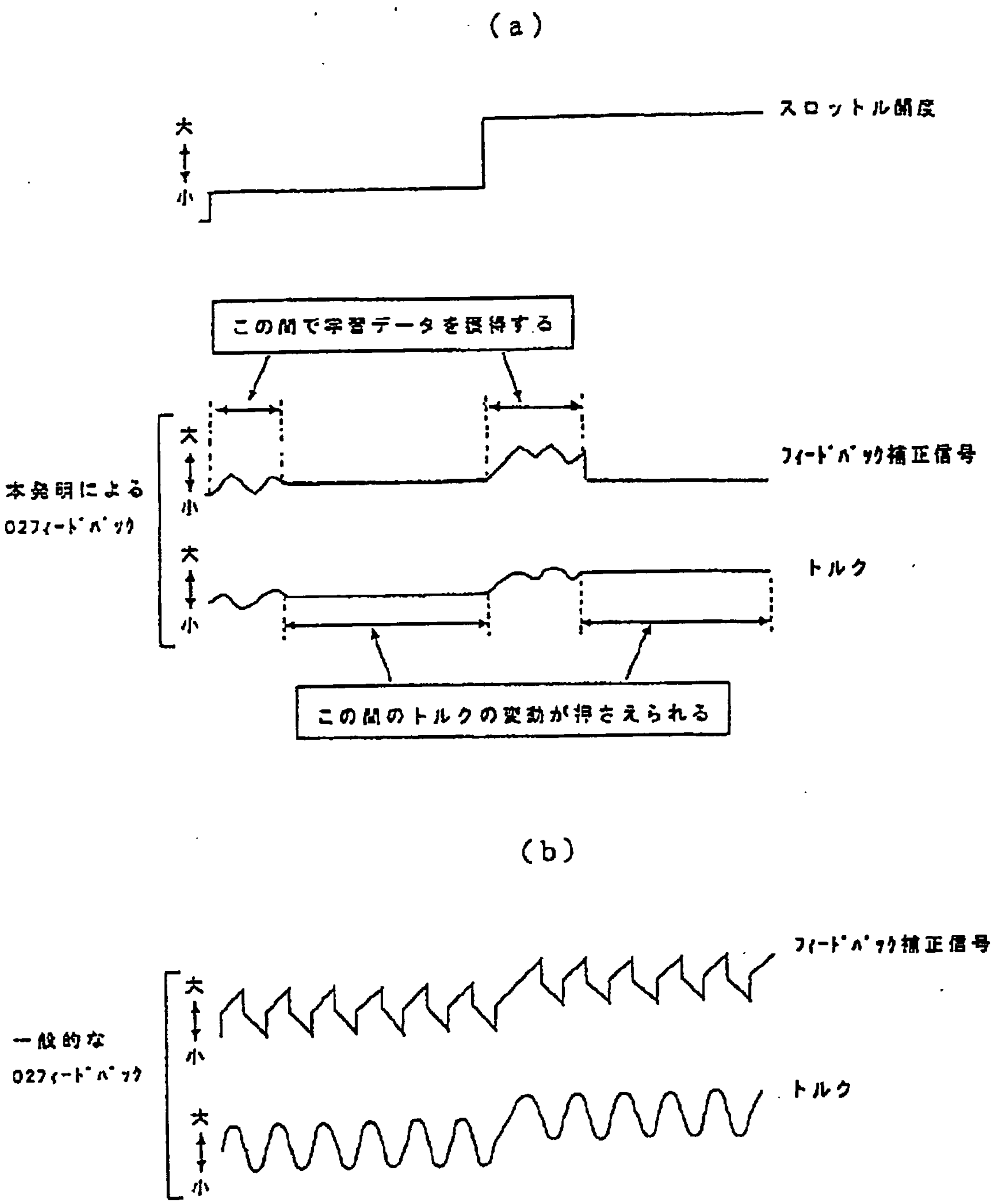
[Drawing 9]



[Drawing 5]

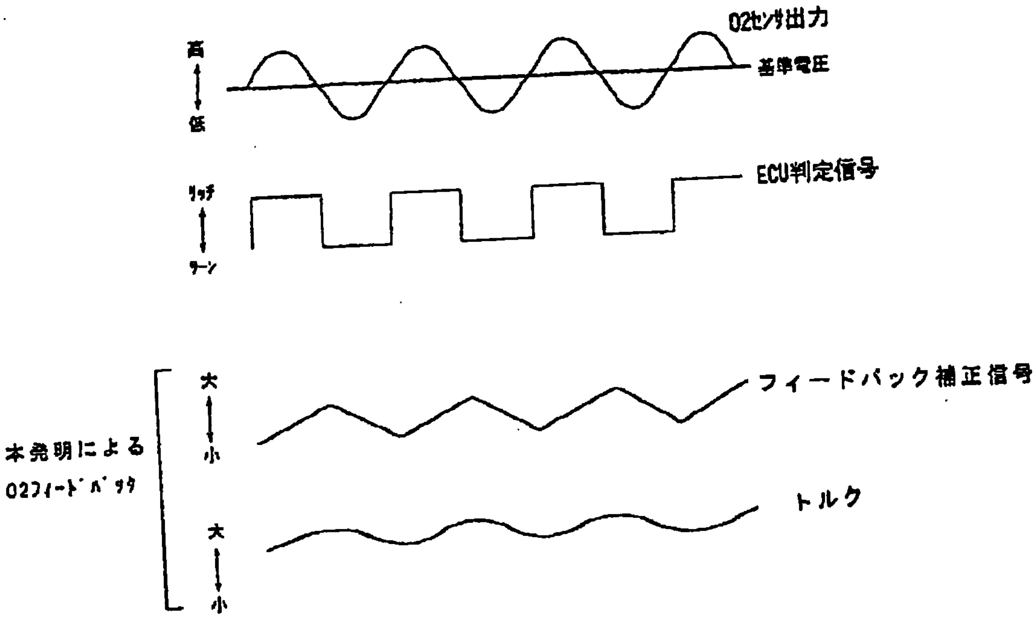


[Drawing 6]

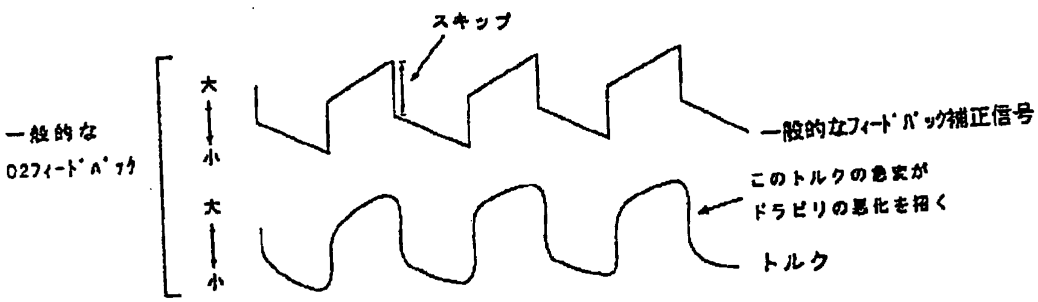

(a)
スロットル開度
大
小
この間で学習データを獲得する
本発明による
O2フィードバック
フィードバック補正信号
トルク
この間のトルクの変動が抑えられる
(b)
フィードバック補正信号
一般的な
O2フィードバック
トルク

[Drawing 7]

(a)



(b)



[Translation done.]

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			３１０Ｈ
Ｇ０５Ｂ　11/32		Ｇ０５Ｂ　11/32	Ｆ
13/02		13/02	Ｌ
13/04		13/04	

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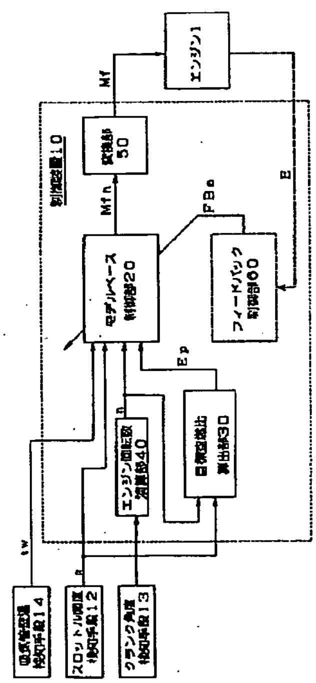
(54)【発明の名称】　エンジン制御方式

(57)【要約】

【課題】　従来の酸素センサを用いたエンジン制御方式の問題点を解決し、空燃比センサとして酸素センサを用いる場合でも、運転者に不快なフィーリングを与えることなく空燃比制御を行うことができるエンジン制御方式を提供すること。

【解決手段】　本発明に係るエンジン制御方式は、空燃比に関するエンジンの順モデルを構成し、この順モデルで得られる仮想空燃比をフィードバックし、該仮想空燃比と所定の目標空燃比とに基づいてエンジンの空燃比に関する動作パラメータの操作量を算出するエンジンの逆モデルを用いて学習機能付きフィードフォワード制御ロジックを構成してエンジンの空燃比を制御すると共に、実質的に前記制御ロジックの教師データを獲得する時のみ、排気空燃比を空燃比センサを用いてフィードバックするフィードバック制御を行い前記制御ロジックの教師データを獲得する。



【特許請求の範囲】

【請求項１】　学習機能付きフィードフォワード制御ロジックによってエンジンの空燃比を制御すると共に、実質的に前記制御ロジックの教師データを獲得する時のみ、排気空燃比を空燃比センサを用いてフィードバックするフィードバック制御を行い前記教師データを獲得することを特徴とするエンジン制御方式。

【請求項２】　前記フィードバック制御を、前記制御ロジックを含めて行うことを特徴とする請求項１に記載のエンジン制御方式。

【請求項３】　前記フィードバック制御を行う時に、フィードバックゲインを小さくして空燃比がステップ的に変化しないようにすることを特徴とする請求項１又は２に記載のエンジン制御方式。

【請求項４】　運転状態の変化に応じてフィードバック制御を行い教師データを獲得することを特徴とする請求項１～３の何れか一項に記載のエンジン制御方式。

【請求項５】　前記制御ロジックを、空燃比に関するエンジンの順モデルを構成し、この順モデルで得られる仮想空燃比をフィードバックし、該仮想空燃比と所定の目標空燃比とに基づいてエンジンの空燃比に関する動作パラメータの操作量を算出するエンジンの逆モデルを用いて実行することを特徴とする請求項１～４の何れか一項に記載のエンジン制御方式。

【請求項６】　前記順モデルを、ニューラル回路網、ファジーニューラル回路網、又はＣＭＡＣの何れか一つを用いて構成することを特徴とする請求項５に記載のエンジン制御方式。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、空燃比を所定の値に制御するエンジン制御方式に関する。

【０００２】

【従来の技術】近年の排ガス規制の強化に伴い未燃焼ガスを低減させるために空燃比を制御することは行われている。前記した空燃比の制御方式としては、図９に示すようにエンジンの運転情報に基づいて基本燃料噴射量を決定すると同時に、前記運転情報から補正係数算出部でその時々の運転情報に適合するように補正係数を算出し、前記基本燃料噴射量に前記補正係数を乗算すると共に、エンジンの排気管に酸素センサを設け、この酸素センサの出力をフィードバックしてフィードバック制御部にて前記補正後の基本燃料噴射量をさらに補正するフィードバック補正信号を決定して出力する、所謂、Ｏ２フィードバック制御が一般的に挙げられる。このＯ２フィードバック制御では、酸素センサが理論空燃比にしか反応しないため、図７（ｂ）に示すように空燃比を、理論空燃比を境に周期的にリッチとリーンとに変動した状態に維持することにより、酸素センサをＯＮ／ＯＦＦさせて空燃比を所定の値に維持している。

【０００３】

【発明が解決しようとする課題】しかし、前記したように酸素センサを用いるために空燃比を周期的にリッチとリーンとに変動させせると、図６（ｂ）及び図７（ｂ）に示すように、それに伴いトルクも変動してしまい、従来のＯ２フィードバック制御のように常時、空燃比を変動させていると運転領域によっては、このトルクの変動が体感できるレベルとなり、運転者のフィーリングに影響を及ぼすという問題がある。また、上記した従来のＯ２フィードバック制御では、フィードバックされた酸素センサの出力に基づいて燃料噴射量を決定するので制御の精度を高くするために高い応答性が要求される。従って、従来のＯ２フィードバック制御では、応答性を向上させるためにフィードバックゲインを大きくし、図７（ｂ）に示すように空燃比をステップ的に変化させており、このためトルクの変動が大きくなるという問題もある。本発明は、上記した従来の酸素センサを用いたエンジン制御方式の問題点を解決し、空燃比センサとして酸素センサを用いる場合でも、運転者に不快なフィーリングを与えることなく空燃比制御を行うことができるエンジン制御方式を提供することを目的としている。

【０００４】

【課題を解決するための手段】上記した目的を達成するために、本発明に係るエンジン制御方式は、学習機能付きフィードフォワード制御ロジックによってエンジンの空燃比を制御すると共に、実質的に前記制御ロジックの教師データを獲得する時のみ、排気空燃比を空燃比センサを用いてフィードバックするフィードバック制御を行い前記教師データを獲得することを特徴とするものである。

【０００５】

【発明の実施の形態】以下、添付図面に示した一実施例を参照して、本発明に係るエンジン制御方式の実施の形態について説明する。図１は、エンジン１と本発明に係るエンジン制御方式を実行可能な制御装置１０との関係を示す概略図である。エンジン１は、吸気管２に設けられたエアクリーナ３及び燃料噴射装置４を介してシリンダ５の燃焼室内に混合気を導入し、燃焼後の排気ガスを排気管６を介して大気中に排気する４サイクルエンジンであり、本図では吸気バルブや排気バルブ等の他の構成部材については省略されている。尚、図１中、符号７はクランクケースを、また、符号８はスロットルバルブを各々示している。制御装置１０は、燃料噴射装置４からの燃料噴射量を操作して排気ガス中の空燃比の値を制御するものである。この制御装置１０は、図１に示すように、スロットルバルブ８に設けられたスロットル開度検知手段１２から得られるスロットル開度に関する情報αと、クランクケース７に設けられたクランク角検知手段１３から得られるクランク角に関する情報ｒと、吸気管２に設けられた吸気管壁温検知手段１４から得られる吸

気管壁温に関する情報ｔｗとを入力し、これらの入力情報に基づいて、吸気管２に設けられた燃料噴射装置４の操作量Ｍｆ（即ち、燃料噴射量）を決定して出力すると共に、排気管６に設けられた酸素センサ１５から得られる実際の空燃比に関する検知信号Ｅを、必要に応じて入力して、この情報に基づく補正及び学習を行い常時最適な制御が行えるように構成されている。

【０００６】図２は、制御装置１０の構成を示す概略ブロック図である。制御装置１０は、目標空燃比Ｅｐに沿ってフィードフォワード制御ロジックを用いて燃料噴射量を決定するモデルベース制御部２０、前記目標空燃比Ｅｐを算出する目標空燃比算出部３０、エンジン回転数演算部４０、変換部５０、及び前記モデルベース制御部２０のずれを補正ために、モデルベース制御部２０によるフィードフォワード制御を実行しながら酸素センサ１５からの出力に基づいてフィードバック制御を行うフィードバック制御部６０を備え、フィードフォワード制御を実行する通常制御モード又はフィードフォワード制御を行いながら前記フィードバック制御を実行するフィードバック補正モードの何れかで作動する。モデルベース制御部２０は、エンジン回転数演算部４０で算出されたエンジン回転数ｎ、及びスロットル開度α、吸気管壁温ｔｗ、及び目標空燃比算出部３０で算出された目標空燃比Ｅｐを入力し、これらの情報に基づいて燃料噴射装置４の基本操作量Ｍｆｎを決定し、変換部５０で、前記基本操作量Ｍｆｎをエンジン１の燃料噴射サイクルに変換して操作量Ｍｆとして制御装置１０から出力する。目標空燃比算出部３０は、エンジン回転数ｎ及びスロットル開度αを入力し、これらの情報に基づいて、その時々のエンジンの運転状態に合った目標空燃比Ｅｐを決定してモデルベース制御部２０に出力する。フィードバック制御部６０は、制御装置１０がフィードバック補正モードに入れられた時のみ機能し、酸素センサ１５からの出力信号Ｅを入力し、前記出力信号Ｅに基づいてフィードバック補正信号ＦＢａを決定してモデルベース制御部２０に出力するＯ２フィードバック制御を実行しモデルベース制御部２０と実際のエンジン１とのずれを補正するための学習データを獲得する。

【０００７】（モデルベース制御部について）以下、図３～図５を参照してモデルベース制御部２０の構成について説明する。図３は、図２におけるモデルベース制御部２０の構成を示す概略ブロック図である。モデルベース制御部２０は、吸気管２内の空気の挙動をモデル化した空気系順モデル２１、燃料噴射装置４から噴射される燃料の挙動をモデル化した燃料系順モデル２２、及び各順モデル２１及び２２から出力される推定空気量Ａｖ及び推定燃料量Ｆｖに基づいて推定空燃比Ｅｖを算出する推定空燃比演算部２３を備えている。また、モデルベース制御部２０は、推定空燃比演算部２３から出力される推定空燃比Ｅｖを基本操作量演算部２４にフィードバックするフィードバックループを備えている。前記基本操作量演算部２４は、推定空燃比演算部２３から出力される推定空燃比Ｅｖと、目標空燃比算出部３０から出力される目標空燃比Ｅｐとを入力してエンジン１の燃料噴射装置４に対する基本操作量Ｍｆｎ（基本燃料噴射量）を算出する。この基本操作量Ｍｆｎは、モデルベース制御部２０から出力されると共に燃料系順モデル２２にも入力され、燃料系順モデル２２は前記基本操作量Ｍｆｎに基づいて推定燃料量Ｆｖを求める。上記したように、モデルベース制御部２０では、空気系順モデル２１、燃料系順モデル２２、及び推定空燃比演算部２３によりエンジン１の順モデルを構成し、かつ、前記燃料系順モデル２２、推定空燃比演算部２３、及び基本操作量演算部２４を含むフィードバックループを用いて前記エンジン１の順モデルから出力される推定空燃比Ｅｖをフィードバックして基本操作量Ｍｆｎを出力するエンジンの逆モデルを構成している。

【０００８】（燃料系順モデルについて）図４は、前記燃料系順モデル２２の構成を示す概略ブロック図である。この燃料系順モデル２２は、前述したように燃料噴射装置４から噴射された燃料の挙動をモデル化したものである。この燃料系順モデル２２は、非付着燃料演算部２２ａ、付着燃料演算部２２ｂ、一次遅れ部２２ｃ，２２ｄ、燃料付着率推定部２２ｅ、及び蒸発時定数推定部２２ｆを備え、前記基本操作量演算部２４から入力される基本操作量Ｍｆｎ（基本燃料噴射量）から、実際にシリンダ８内に入る燃料量を推定する。前記燃料付着率推定部２２ｅは、エンジン回転数ｎ及びスロットル開度αと燃料付着率ｘとの関係を予め学習させたファジーニューラル回路網、ニューラル回路網、又はＣＭＡＣ等を用いて燃料付着率ｘをモデル化したものであり、エンジン回転数ｎ及びスロットル開度αを入力し、これらの情報に基づいて、燃料噴射装置４から噴射された燃料が吸気管２等の壁面に付着する割合ｘ（以下、燃料付着率ｘ）を推定する。尚、この燃料付着率推定部２２ｅは、図示していないが、必要に応じて、エンジンの運転状態が過渡状態にある時に実際の空燃比と目標空燃比Ｅｐとの比較結果に基づく教師データを入力して、経時変化等が原因で生じる燃料系順モデルの誤差を補正し、学習できるように構成され得る。また、前記蒸発時定数推定部２２ｆは、エンジン回転数ｎ、スロットル開度α、及び吸気管壁温ｔｗ（又はエンジン水温）と蒸発時定数τとの関係を予め学習させたファジーニューラル回路網、ニューラル回路網、又はＣＭＡＣ等を用いて蒸発時定数τをモデル化したものであり、エンジン回転数ｎ、スロットル開度α、及び吸気管壁温ｔｗ（又はエンジン水温）を入力し、これらの情報に基づいて、壁面に付着した燃料が蒸発する時定数τ（以下、蒸発時定数τ）を推定する。尚、この蒸発時定数推定部２２ｆも、前記燃料付着率推定部２２ｅと同様、図示していないが、必要に応じて、

エンジンの運転状態が過渡状態にある時に実際の空燃比と目標空燃比Ｅｐとの比較結果に基づく教師データを入力して、経時変化等が原因で生じる燃料系順モデルの誤差を補正し、学習できるように構成され得る。上記した燃料付着率推定部２２ｅ及び蒸発時定数推定部２２ｆについては、本願出願人が平成８年１０月１４日に出願した特願平８－２７１１８８号により詳細に開示されている。非付着燃料演算部２２ａは、前記燃料付着率推定部２２ｅから得られる燃料付着率ｘに基づいて、基本操作量演算部２４から入力される基本操作量Ｍｆｎ（即ち、基本燃料噴射量）における燃料噴射装置４から直接シリンダ５の燃焼室内に入る燃料量を算出する。付着燃料演算部２２ｂは、前記燃料付着率推定部２２ｅから得られる燃料付着率ｘに基づいて、基本操作量演算部２４から入力される基本操作量Ｍｆｎ（基本燃料噴射量）において一度壁面に付着した後でシリンダ５内に入る燃料量を算出する。前記非付着燃料演算部２２ａ及び付着燃料演算部２２ｂから得られる燃料量は、各々一次遅れ部２２ｃ，２２ｄで、蒸発時定数演算部２２ｆから得られる蒸発時定数τ１，τ２に基づいて一次遅れ系にて近似された後、加算され、推定燃料量Ｆｖとして燃料系順モデル２２から出力される。尚、通常、エンジン１における燃料噴射装置４から噴射された燃料の挙動をモデル化する場合、噴射燃料が燃料噴射装置４からシリンダ５内に入るまでの無駄時間を考慮して、図４に破線で示すように無駄時間分だけ位相を遅らせる無駄時間用位相遅れ部２２ｇを設ける必要があるが、本実施例における燃料系順モデル２２では、前記無駄時間分だけ燃料系順モデルの位相を進ませることで無駄時間用位相遅れ部２２ｇを設ける必要をなくしている。これにより、燃料系順モデル２２は単純な一次遅れ系になるので、燃料系順モデル２２の出力を用いてフィードバック制御を行う場合に、フィードバックゲインを大きくすることが可能になり、過渡時にも適正な基本操作量が得られる正確な逆モデルを構成している。

【０００９】（空気系順モデルについて）図５は、前記空気系順モデル２１の構成を示す概略ブロック図である。この空気系順モデル２１は、スロットル開度用位相進み部２１ａ、空気量演算部２１ｂ、圧力変換部２１ｃ、吸気負圧演算部２１ｄ、体積効率推定部２１ｅ、及びエンジン回転数用位相進み部２１ｆを備えている。

【００１０】（各位相進み部２１ａ及び２１ｆについて）前記スロットル開度用位相進み部２１ａ及びエンジン回転数用位相進み部２１ｆは、前記燃料系順モデル２２において、取り除いた無駄時間（即ち、噴射燃料が燃料噴射装置４から噴射された後、シリンダ５内に入るまでの時間）分だけ入力されるスロットル開度α及びエンジン回転数ｎの位相を進める。具体的には、各位相進み部２１ａ及び２１ｆは、時刻に対するエンジン回転数又はスロットル開度の変化パターンを予め学習したニューラル回路網を各々備えており、このニューラル回路網により、過去の複数の時刻におけるエンジン回転数又はスロットル開度に基づいてエンジン回転数又はスロットル開度の未来値を求めることにより、位相を進める。このように、空気系順モデル２１において、スロットル開度及びエンジン回転数の位相を無駄時間分だけ進めることにより、燃料系順モデル２２及び空気系順モデル２１の両方の位相を無駄時間分だけ進めることになり、燃料系順モデル２２で無駄時間を取り除いたことにより推定燃料量Ｆｖと推定空気量Ａｖとの位相のずれがなくなり、推定空燃比演算部２３で適正な推定空燃比を推定することが可能になる。また、例えば、筒内噴射式のエンジンのように、噴射燃料が燃料噴射装置からシリンダ内に入るまでの無駄時間が存在しないものや、前記無駄時間が無視できる程小さいものの場合には、噴射燃料の挙動をモデル化する時に、始めから無駄時間用位相遅れ部を設ける必要がないので、空気系順モデル２１における各位相進み部２１ａ及び２１ｆも設ける必要はない。尚、各位相の進め方はニューラル回路網を用いる方法に限られず任意の方法でよく、例えば、最小二乗法等を用いてもよい。

【００１１】空気量Ａｖ及び吸気負圧Ｐｍａｎの演算部２１ｂ、２１ｄは流体力学的な数式（１），（２）でのモデル化を行う。

$$\text{空気量}\ Av(\alpha, Pman) = Ct\frac{\Pi}{4}D^2\frac{Pamb\sqrt{k}}{\sqrt{RTamb}}\beta_1(\alpha)\beta_2(Pmam)+\dot{m}ao \quad \cdots(1)$$

$$\text{吸気負圧}\ \dot{P}mam = -\frac{1}{\tau}Pmam\frac{RTmam}{V}Av(\alpha, Pmam) \cdots(2)$$

ここで、Ｃｔはスロットルでの流量計数、Ｄはスロットルの直径、Ｐａｍｂは大気圧、ｋは空気の比熱、Ｔａｍｂは大気温、Ｒは気体定数、Ｍａｏは補正計数、Ｔｍａｎは吸気管温度、Ｖは吸気管体積、β１はスロットル開度に依存する計数、β２は吸気管圧力に依存する計数である。また、体積効率ηに関しては数式によるモデル化が困難なため、体積効率推定部２１ｅは、エンジン回転数信号ｎ及びスロットル開度αと体積効率ηとの関係を予め学習させたファジーニューラル回路網（又はニューラル回路網、ＣＭＡＣ等）によるモデル化を行う。尚、体積効率推定部２１ｅからの出力は、制御装置１０がフィードバック補正モードにある時に、前記フィードバック制御部３０からのフィードバック補正信号ＦＢａにより補正され、体積効率推定部２１ｅは、補正後の体積効

率ηを教師データとして学習可能に構成されている。

【００１２】（目標空燃比算出部３０について）目標空燃比算出部３０は、スロットル開度α及びエンジン回転数ｎを入力し、これらの情報に基づいて、その時々に最適な目標空燃比を決定してモデルベース制御部２０に出力する。

【００１３】（フィードバック制御部６０について）次に、フィードバック制御部６０を用いたフィードバック補正モードについて説明する。上記した制御装置１０は、図６（ａ）に示すように、エンジンの運転状態が所定以上変化した場合、例えば、スロットル開度が所定の変化率以上で変化した場合、通常の制御からフィードバック補正モードに切り替わる。このフィードバック補正モードは、モデルベース制御部２０により目標値を一定に維持したフィードフォワード制御を行いながら、酸素センサ１５の出力信号Ｅに基づいてＯ２フィードバック制御を行い、モデルベース制御部２０におけるエンジンの順モデルと実際のエンジンとの間のずれを補正するための教師データを獲得するためのモードであり、このモード中、目標空燃比算出部３０は目標空燃比Ｅｐを理論空燃比に維持する。具体的には、フィードバック制御部６０は、モデルベース制御部２０により理論空燃比を目標値Ｅｐとしてフィードフォワード制御ロジックで制御されるエンジン１の実際の空燃比に関する情報を排気管６に設けられた酸素センサ１５の出力信号Ｅとしてフィードバックし、図７に示すように、前記出力信号が”１”の場合、即ち、空燃比がリッチの場合には燃料噴射量が少なくなるように、また、前記出力信号が”０”の場合、即ち、空燃比がリーンの場合には燃料噴射量が多くなるようにモデルベース制御部２０の順モデルの出力を補正するフィードバック補正信号ＦＢａを決定して出力する。前記フィードバック制御部６０から出力されるフィードバック補正信号ＦＢａは、具体的には、モデルベース制御部２０の空気系順モデル２１における体積効率推定部２１ｅから出力される体積効率ηを補正するもので、図３に示すように空気系順モデル２１に入力され、図５に示すように体積効率推定部２１ｅからの出力に補正値として加算される。このフィードバック補正モードは、モデルベース制御部２０と実際のエンジン１との間のずれが許容できる範囲内になるような教師データが獲得されるまで、即ち、フィードバック制御部６０の出力ＦＢａ（又はモデルベース制御部２０の出力Ｍｆｎ）が図６（ａ）及び図７（ａ）に示すように理論空燃比を挟んでリッチとリーンとに周期的に振動し始めるまで行われ、その後は、制御装置１０は通常制御モードに切り換えられる。空気系順モデル２１は、フィードバック補正モードにより得られた補正後の体積効率ηを教師データとして獲得し、この教師データに基づいて学習を行う。これにより、学習後は、エンジンの順モデルと実際のエンジンとの間のずれが許容できる範囲内になる。尚、前記フィードバック補正モード中も、制御装置１０は、モデルベース制御部２０によりフィードフォワード制御ロジックに基づいた制御を実行しているので、このフィードバック補正モード中のＯ２フィードバック制御には応答性を重視する必要がない。従って、図７（ａ）に示すように、この制御装置１０では、前記フィードバック制御部６０のフィードバックゲインを小さくすることができ、フィードバック補正モード中に、燃料噴射量がステップ的に変化しないように、即ち、酸素センサ１５からの出力がリッチの場合には徐々に燃料噴射量を減らすように、また、酸素センサ１５からの出力がリーンの場合には徐々に燃料噴射量を増やすように補正信号ＦＢａを決定することができる。

【００１４】（別の実施例）図８は、本発明に係るエンジン制御方式の別の実施例を実行可能な制御装置の概略ブロック図を示している。尚、本実施例に係る制御装置の入出力情報とエンジンとの関係、酸素センサの出力とフィードバック補正信号との関係は、図１～図７に示した第一実施例と同じであるので重複する説明は省略する。この制御装置は、マップ制御部１１０及びフィードバック制御部１３０を備え、マップ制御部１１０によるフィードフォワード制御を実行する通常制御モード又は、前記フィードフォワード制御を行いながら酸素センサからの出力信号Ｅに基づいてフィードバック制御を実行するフィードバック補正モードの何れかで作動する。マップ制御部１１０は、予め、様々なエンジン回転数ｎ及びスロットル開度αに対して最適な燃料噴射量が得られる基本操作量Ｍｆｎを実験等により求め、その結果をマップ化したもので、エンジン回転数ｎ及びスロットル開度αを入力し、それらの条件に合った最適な基本操作量Ｍｆｎを出力する。このマップ制御部１１０は、学習可能なフィードフォワード制御が実行できる構成であれば任意の構成でよく、例えば、ＣＭＡＣ等の学習可能なマップで構成してもよく、また、通常のマップとマップからの出力を補正することができる学習可能な補正部とで構成してもよい。制御装置１０は、エンジンの運転状態が所定以上変化した場合、例えば、スロットル開度が所定の変化率以上で変化した場合、通常の制御からフィードバック補正モードに切り替わる（図６（ａ）参照）。フィードバック補正モードは、酸素センサの出力信号Ｅに基づいてＯ２フィードバック制御を行い、マップ制御部１１０におけるマップデータと実際のエンジンとの間のずれを補正するための教師データを獲得するためのモードであり、このモード中、マップ制御部１１０は空燃比を理論空燃比に維持するように基本操作量Ｍｆｎを決定する。フィードバック制御部１３０は、マップ制御部１１０により理論空燃比を維持するように制御されるエンジン１の実際の空燃比に関する情報を排気管に設けられた酸素センサの出力信号Ｅとしてフィードバックし、前記出力信号が”１”の場合、即ち、空燃比がリ

ッチの場合には燃料噴射量が少なくなるように、また、前記出力信号が”０”の場合、即ち、空燃比がリーンの場合には燃料噴射量が多くなるようにマップ制御部１１０からの基本操作量Ｍｆｎを補正するフィードバック補正信号ＦＢａを決定して出力する（図７（ａ）参照）。前記フィードバック補正信号ＦＢａは、マップ制御部１１０から出力される基本操作量Ｍｆｎに加算され、その結果、エンジンの燃料噴射装置は、フィードバック補正モード中は、基本操作量Ｍｆｎにフィードフォワード補正信号ＦＢａを加算した操作量Ｍｆにより操作される。このフィードバック補正モードは、マップ制御部１１０におけるマップデータと実際のエンジン１との間のずれが許容できる範囲内になるような教師データが獲得されるまで、即ち、操作量Ｍｆが図６（ａ）に示したように理論空燃比を挟んでリッチとリーンとに周期的に振動し始めるまで行われ、その後、制御装置は通常制御モードに切り換えられる。マップ制御部１１０は、フィードバック補正モードにより得られた補正後の操作量Ｍｆを教師データとして獲得し、この教師データに基づいて、その時のエンジン回転数ｎ及びスロットル開度αに対応させて学習を行う。これにより、学習後は、マップ制御部１１０のマップデータと実際のエンジンとの間のずれが許容できる範囲内になる。尚、前記フィードバック補正モード中も、制御装置は、マップ制御部１１０によるフィードフォワード制御を実行しているので、このフィードバック補正モード中のＯ２フィードバック制御には第一実施例と同様、応答性を重視する必要がない。従って、本実施例の制御装置の場合も、第一実施例の制御装置１０と同様、図７（ａ）に示すように、前記フィードバック制御部１３０のフィードバックゲインを小さくすることができ、フィードバック補正モード中に、燃料噴射量がステップ的に変化しないように、即ち、酸素センサからの出力信号がリッチの場合には徐々に燃料噴射量を減らすように、また、酸素センサからの出力がリーンの場合には徐々に燃料噴射量を増やすように補正信号ＦＢａを決定することができる。

【００１５】（実施例効果）以上説明した第一及び第二の実施例の制御装置は、通常制御をモデルベース制御部２０（又はマップ制御部１１０）で行い、前記モデルベース制御部２０におけるエンジンの順モデル（又はマップ制御部１１０におけるマップデータ）と実際のエンジンとのずれを補正するための学習データを獲得するために通常制御モードからフィードバック補正モードに切換えてＯ２フィードバック制御を行い、学習データ獲得後は通常制御モードに切り換えるように構成されているので、従来の制御方法のようにＯ２フィードバック制御を常時行う必要がなくなり、Ｏ２フィードバック制御時の空燃比の変動によるトルク変動を短時間に抑えることができるという効果を奏する。また、本実施例の制御装置は、エンジンの運転状態の変化に応じて学習データを獲得するように構成されているので、同一運転状態でＯ２フィードバック制御を長時間行う必要がなくなるという効果を奏する。さらに、本実施例の制御装置は、通常制御をフィードフォワード制御ロジックを用いて行い、また、フィードバック補正モード中も基本操作量をフィードフォワード制御ロジックに基づくモデルベース制御部２０（又はマップ制御部１１０）を用いて決定し、Ｏ２フィードバック制御は学習データ獲得のために行っているので、Ｏ２フィードバック制御の応答性を高くする必要がなく、従って、フィードバックゲインを小さくすることができ、空燃比をステップ的に変化させる必要もなくなるので、Ｏ２フィードバック制御中の空燃比の変動を最低限に抑えることが可能になり、その結果、Ｏ２フィードバック制御を行うことによるトルクの変動も最低限に抑えることができるという効果を奏する。

【００１６】（他の適用例）以上説明した本実施例では、フィードバック補正モード中は、第一実施例においては、目標空燃比を理論空燃比に維持し、また、第二実施例いおいてはマップ制御部１１０の出力を理論空燃比を維持しているが、これは本実施例に限定されることなく、空燃比を検出するセンサとして、酸素センサ以外の空燃比センサを使用する場合には、使用する空燃比センサの反応値に合わせた空燃比に維持すればよい。また、本実施例では、フィードバック補正モード中に、酸素センサからの出力に基づいてフィードバック制御部６０でフィードバック補正値を決定しているが、これは本実施例に限定されることなく、例えば、目標空燃比や基本操作量と酸素センサからの出力とを入力して、それらの差に基づいてフィードバック補正値を決定してもよい。さらに、本実施例では、スロットル開度の変化率に基づいて通常制御モードからフィードバック補正モードへの切換を行っているが、フィードバック補正モードへの切換のタイミングは本実施例に限定されることなく、例えば所定の時間毎に切り換えてもよく、エンジン回転数の変化率に基づいて切り換えてもよく、予めアイドリング状態や高負荷高回転状態等の種々の運転モードを決めておき前記運転モードの変化に基づいて切り換えてもよく、又、外部からの指示により強制的に切り換えるようにしてもよい。また、本実施例では、フィードバック制御部６０のフィードバックゲインを小さく抑えているが、フィードバック補正モード中のフィードバックゲインの大きさは本実施例に限定されることなく、例えば、従来のようにステップ的に変化させてもよく、また、エンジンの運転状態、運転者のフィーリング、又はドラビリ性に応じて変化させてもよい。

【００１７】

【発明の効果】以上説明した本発明に係るエンジン制御方式によれば、学習機能付きフィードフォワード制御ロジックによってエンジンの空燃比を制御すると共に、排気空燃比を空燃比センサを用いてフィードバックし、前

記学習機能付きフィードフォワード制御ロジックを含めたフィードバック制御を行うことにより前記学習機能付きフィードフォワード制御の教師データを獲得しているので、例えば、空燃比センサとして酸素センサを用いた場合でも、従来のＯ２フィードバック制御のように常時空燃比を変動させる必要がなく、従って、運転者に不快なフィーリングを与えることなく空燃比を最適な状態に制御することができるという効果を奏し、特に、空燃比変動がドライバのドラビリ悪化として現れやすい二輪車に最適である。

【図面の簡単な説明】

【図１】　エンジン１と本発明に係るエンジン制御方式を実行可能な制御装置１０との関係を示す概略図である。

【図２】　制御装置１０の構成を示す概略ブロック図である。

【図３】　図２におけるモデルベース制御部２０の構成を示す概略ブロック図である。

【図４】　燃料系順モデル２２の構成を示す概略ブロック図である。

【図５】　空気系順モデル２１の構成を示す概略ブロック図である。

【図６】　（ａ）は本発明に係るＯ２フィードバック制御実行中の、運転状態に対するフィードバック補正信号及びトルク変動を、（ｂ）は従来のＯ２フィードバック制御実行中の、運転状態に対するフィードバック補正信号及びトルク変動を各々示している。

【図７】　（ａ）は本発明に係るＯ２フィードバック制御実行中の、酸素センサの出力に対するフィードバック補正信号及びトルク変動を、（ｂ）は従来のＯ２フィードバック制御実行中の、酸素センサの出力に対するフィードバック補正信号及びトルク変動を各々示している。

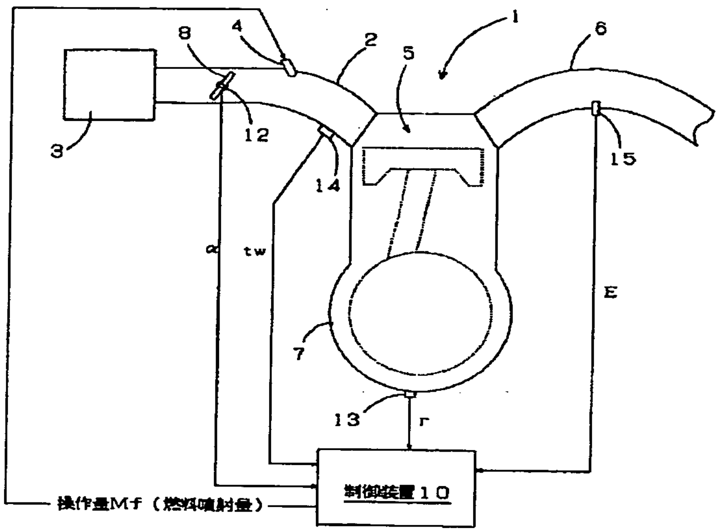
【図８】　本発明に係るエンジン制御方式の別の実施例を実行可能な制御装置の概略ブロック図を示している。

【図９】　従来のＯ２フィードバック制御ロジックの概略ブロック図である。

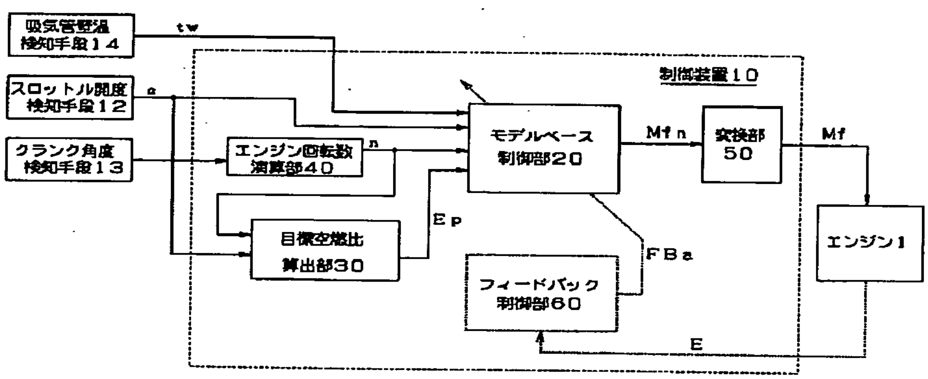
【符号の説明】

1	エンジン
2	吸気管
3	エアクリーナ
4	燃料噴射装置
5	シリンダ
6	排気管
7	クランクケース
8	スロットルバルブ
１０	制御装置
１２	スロットル開度検知手段
１３	クランク角検知手段
１４	吸気管壁温検知手段
１５	酸素センサ
２０	モデルベース制御部
２１	空気系順モデル
２１ａ	スロットル開度用位相進み部
２１ｂ	空気量演算部
２１ｃ	圧力変換部
２１ｄ	吸気負圧演算部
２１ｅ	体積効率推定部
２１ｆ	エンジン回転数用位相進み部
２２	燃料系順モデル
２２ａ	非付着燃料演算部
２２ｂ	付着燃料演算部
２２ｃ	一次遅れ部
２２ｄ	一次遅れ部
２２ｅ	燃料付着率推定部
２２ｆ	蒸発時定数推定部
２３	推定空燃比演算部
２４	基本操作量演算部
３０	目標空燃比算出部
４０	エンジン回転数演算部
５０	変換部
６０	フィードバック制御部
α	スロットル開度
ｒ	クランク角
ｔｗ	吸気管壁温
ｎ	エンジン回転数
Ｍｆ	操作量
Ｍｆｎ	基本操作量
Ｅ	実際の空燃比に関する検知信号
Ｅｐ	目標空燃比
Ｅｖ	推定空燃比
Ａｖ	推定空気量
Ｆｖ	推定燃料量
ＦＢａ	フィードバック補正信号

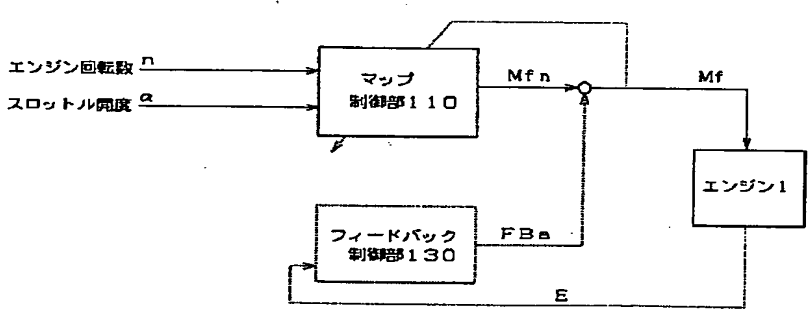
【図1】


1
2
3
4
5
6
7
8
12
13
14
15
α
tw
E
r
制御装置10
操作量Mf（燃料噴射量）

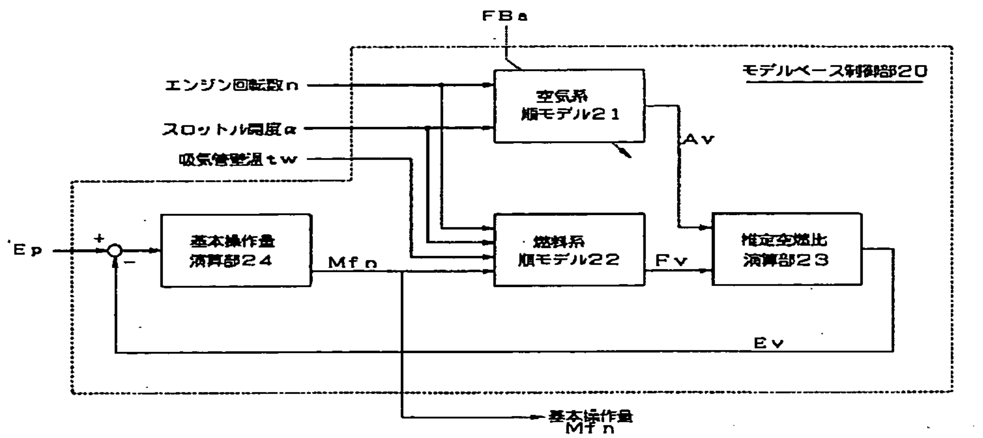
【図2】


吸気管壁温
検知手段14
tw
スロットル開度
検知手段12
α
クランク角度
検知手段13
制御装置10
エンジン回転数
演算部40
n
モデルベース
制御部20
Mfn
変換部
50
Mf
目標空燃比
算出部30
Ep
FBa
エンジン1
フィードバック
制御部60
E

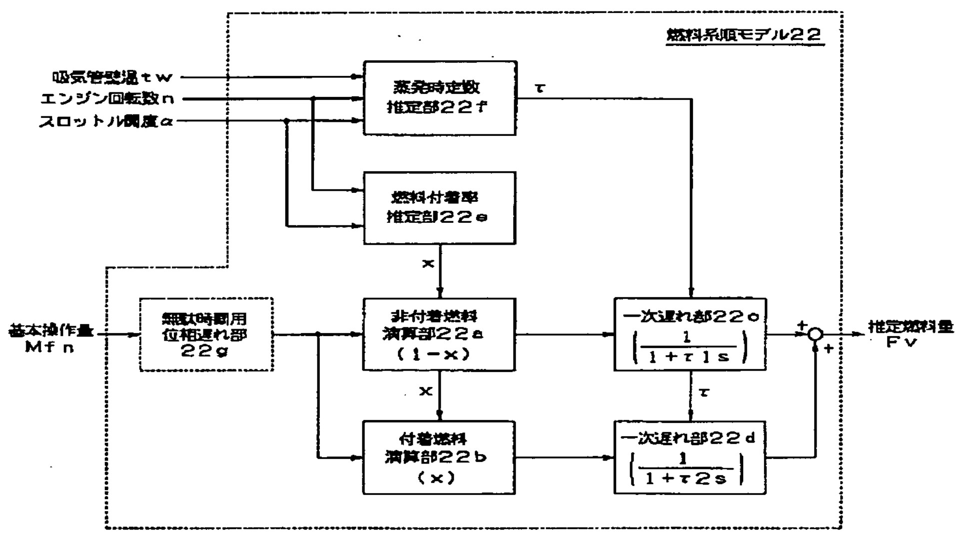
【図8】


エンジン回転数 n
スロットル開度 α
マップ
制御部110
Mfn
Mf
エンジン1
フィードバック
制御部130
FBa
E

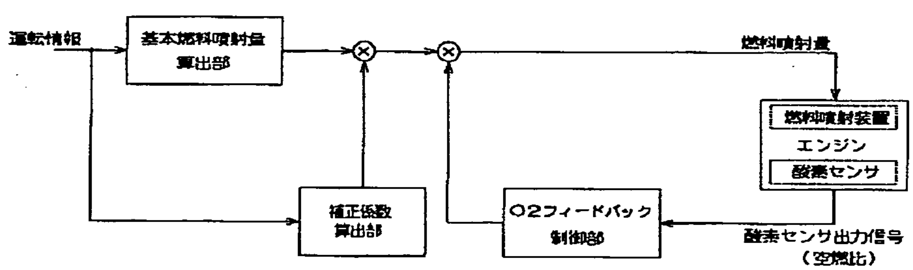
【図３】


FBa
モデルベース制御部20
エンジン回転数n
スロットル開度α
吸気管壁温tw
空気系
順モデル21
Av
Ep
基本操作量
演算部24
Mfn
燃料系
順モデル22
Fv
推定空燃比
演算部23
Ev
基本操作量
Mfn

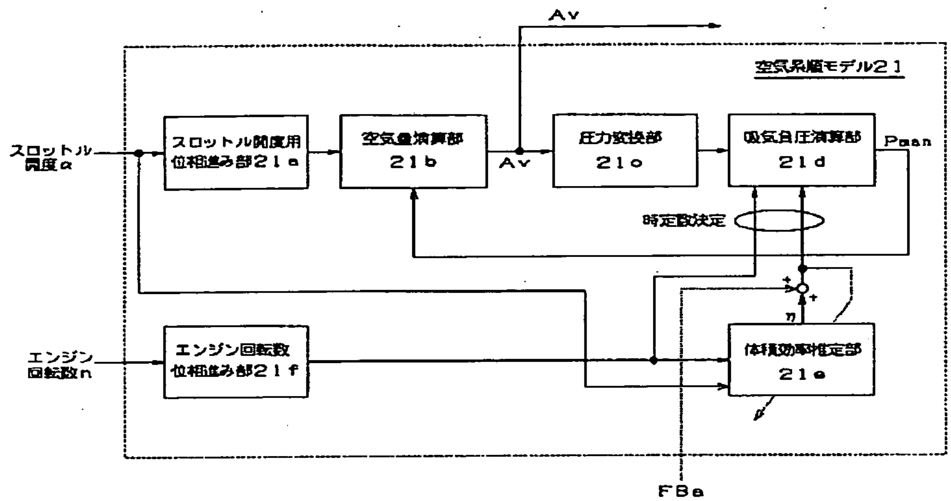
【図４】


燃料系順モデル22
吸気管壁温tw
エンジン回転数n
スロットル開度α
蒸発時定数
推定部22f
τ
燃料付着率
推定部22e
x
基本操作量
Mfn
無駄時間用
位相遅れ部
22g
非付着燃料
演算部22a
(1−x)
一次遅れ部22c
1/(1+τ1s)
推定燃料量
Fv
付着燃料
演算部22b
(x)
一次遅れ部22d
1/(1+τ2s)

【図９】

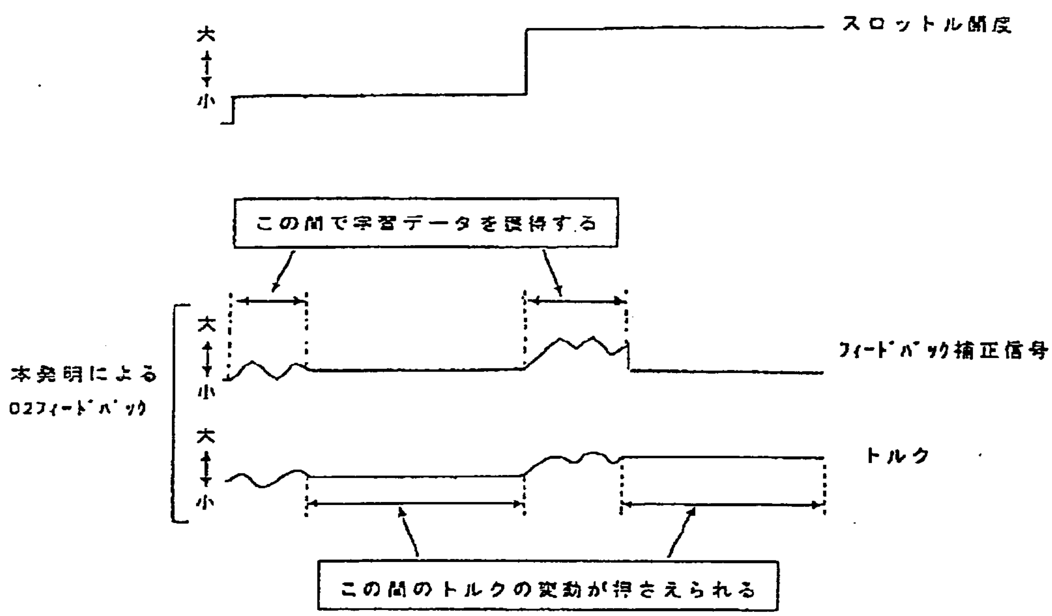

運転情報
基本燃料噴射量
算出部
燃料噴射量
燃料噴射装置
エンジン
酸素センサ
補正係数
算出部
O2フィードバック
制御部
酸素センサ出力信号
(空燃比)

【図５】

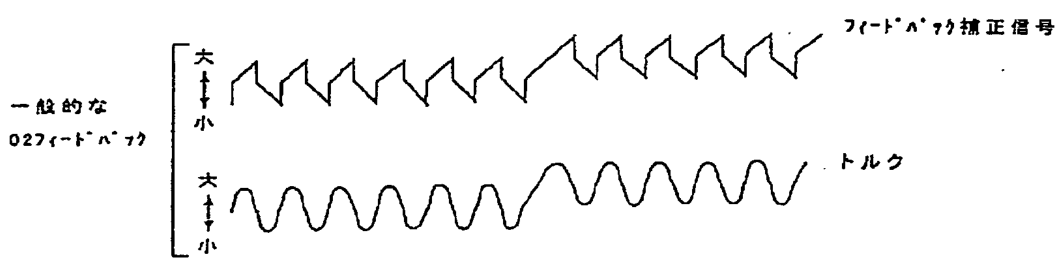

Av
空気系順モデル２１
スロットル開度α
スロットル開度用位相進み部２１ａ
空気量演算部２１ｂ
Av
圧力変換部２１ｃ
吸気負圧演算部２１ｄ
Pman
時定数決定
+
+
η
エンジン回転数n
エンジン回転数位相進み部２１ｆ
体積効率推定部２１ｅ
FBa

【図6】

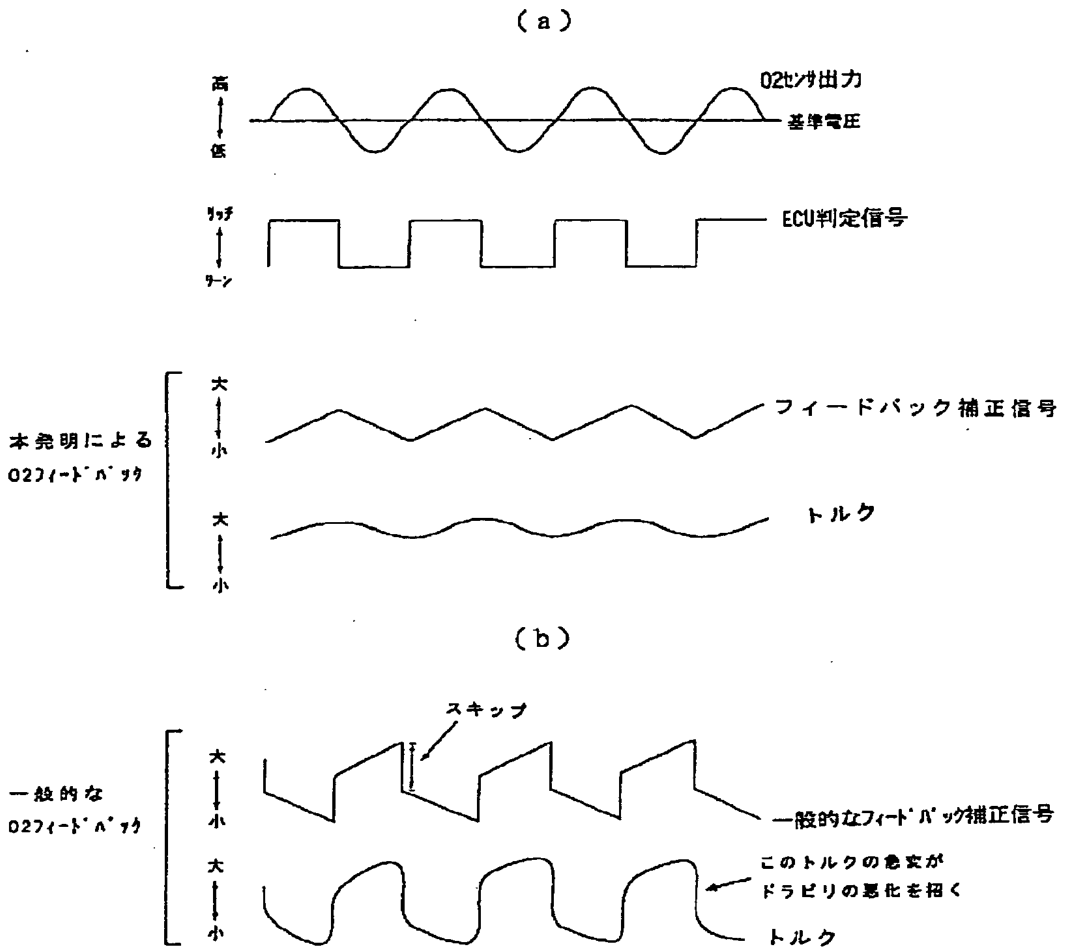
（a）


大
小
スロットル開度
この間で学習データを保持する
本発明による
O2フィードバック
大
小
フィードバック補正信号
大
小
トルク
この間のトルクの変動が抑えられる

（b）


一般的な
O2フィードバック
大
小
フィードバック補正信号
大
小
トルク

【図7】


(a)
高
低
O2センサ出力
基準電圧
リッチ
リーン
ECU判定信号
本発明による
O2フィードバック
大
小
フィードバック補正信号
トルク
(b)
一般的な
O2フィードバック
スキップ
一般的なフィードバック補正信号
このトルクの急変が
ドラビリの悪化を招く
トルク

CLAIMS

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(57) [Claim(s)]

[Claim 1] It is based on the simulation model which expresses the dynamic behavior of fuel [near the injector of each cylinder] in the fuel-injection control unit characterized by providing the following. A fuel behavior simulation means to calculate the fuel quantity in an anticipation cylinder which was probably poured in into each cylinder (105), A specific state detection means to detect that the operational status of an internal combustion engine is in specific operational status (107), A parameter-identification means to identify the parameter contained in the aforementioned fuel behavior simulation means (105) when it is detected by this specific state detection means that an internal combustion engine is in a specific state (108), When it is detected by the aforementioned specific state detection means (107) that an internal combustion engine is not in a specific state It is based on the output of the aforementioned air-fuel-ratio sensor (100), and the fuel quantity in an anticipation cylinder calculated by the fuel behavior simulation means (105) using the identified parameter by this parameter-identification means (108). The fuel-injection control unit characterized by including an amendment fuel-oil-consumption amendment means (106) for the fuel quantity determined by the aforementioned fuel-oil-consumption operation means (103). The air-fuel ratio sensor which is installed in the exhaust pipe of an internal combustion engine, and detects the air-fuel ratio of exhaust gas (100) An operational status detection means to detect the operational status of internal combustion engines other than an air-fuel ratio (101), exhaust gas predetermined from the output of this air-fuel ratio sensor (100), and the amount of operational status detected with this operational status detection means (101) -- with a fuel quantity operation means (102) in a criteria target cylinder to calculate the fuel quantity which should be injected into each cylinder, in order to acquire a character Based on the result of an operation of this fuel quantity operation means (102) in a criteria target cylinder, the reverse model showing the dynamic behavior of fuel [near the injector of each cylinder] of a simulation model is used. The injector which injects fuel in the style of [near the inlet valve] an inlet pipe based on the result of an operation of a fuel-oil-consumption operation means (103) to determine the fuel quantity which should be injected from an injector, and this fuel-oil-consumption operation means (103) (104)

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Industrial Application]
this invention relates to the control unit of the fuel oil consumption of an internal combustion engine, and relates to the control unit which determines fuel oil consumption based on the fuel behavior model showing the dynamic behavior of the fuel near the injector attached in the inlet pipe of an internal combustion engine in more detail.
[Description of the Prior Art]
As a method of controlling the fuel quantity which should be injected from the injector of an internal combustion engine, these people proposed the injection fuel control system which used the precise SHIMYURESHO model showing the dynamic behavior of the fuel near the injector installed in the inlet pipe of an internal combustion engine (refer to JP,1-200040,A official report).
The simulation model which makes a state variable the fuel quantity fw adhering to the inlet-pipe internal surface in an imagination closed space near the injector (control volume) and fuel quantity fv which evaporates in this closed space in this method is built. Since feedback control of the fuel oil consumption from an injector is carried out based on the above-mentioned state variable so that the fuel quantity which actually flowed in the cylinder from the output of the air-fuel ratio sensor formed in the flueway may be detected and the value may be in agreement with desired value, An air-fuel ratio predetermined in a high precision is maintainable. However, this method is the so-called feedback control, i.e., the control which the exhaust air air-fuel ratio of an internal combustion engine is detected, begins, and becomes correctable [fuel oil consumption], generally had the fault that control speed was slow, and when operational status changed rapidly, it had the fault that the precision of control fell.
In order to cancel this fault, these people have proposed what controls an internal combustion engine by the control unit which performs the control operation in the relation between the dynamic characteristics of an internal combustion engine, and a reverse property from the inflow fuel quantity in a target cylinder which becomes settled beforehand according to the operational status of an internal combustion engine (Japanese Patent Application No. 2-193806).
[Problem(s) to be Solved by the Invention]
However, although the parameter of a control unit needs to describe correctly the model which has the relation between the dynamic characteristics of an internal combustion engine, and a reverse property if it is in the control unit which used the reverse model, it is difficult to get to know a parameter exact for dispersion in the manufacture process of an internal combustion engine, or aging, and there is a possibility that the error of this parameter may become a factor and control may become unstable.
this invention is made in view of the above-mentioned trouble, and while corresponding to the operational status of an internal combustion engine promptly and determining suitable fuel oil consumption, it aims at following a change of an internal combustion engine with time, and offering the fuel-injection control unit of an amendment internal combustion engine for fuel oil consumption.
[The means for solving a technical problem]
Although the basic composition of the fuel-oil-consumption control unit of such an internal combustion engine is shown in a view 1, it is constituted as follows.
Namely, the air-fuel ratio sensor 100 which is installed in the exhaust pipe of an internal combustion engine, and detects the air-fuel ratio of exhaust gas, An operational status detection means 101 to detect the operational status of internal combustion engines other than an air-fuel ratio, exhaust gas predetermined from the output of the air-fuel ratio sensor 100, and the amount of operational status detected with the operational status detection means 101 -- with a fuel quantity operation means 102 in a criteria target cylinder to calculate the fuel quantity which should be injected into each cylinder, in order to acquire a character A fuel-oil-consumption operation means 103 to determine the fuel quantity which should be injected from an injector using the reverse model of a simulation model which expresses the

dynamic behavior of fuel [near the injector of each cylinder] based on the result of an operation of the fuel quantity operation means 102 in a criteria target cylinder, The injector 104 which injects fuel in the style of [near the inlet valve] an inlet pipe based on the result of an operation of the fuel-oil-consumption operation means 103, A fuel behavior simulation means 105 to calculate the fuel quantity in an anticipation cylinder which was probably poured in into each cylinder based on the simulation model showing the dynamic behavior of fuel [near the injector of each cylinder], A specific state detection means 107 to detect that the operational status of an internal combustion engine is in specific operational status, A parameter-identification means 108 to identify the parameter contained in the fuel behavior simulation means 105 when it is detected by the specific state detection means that an internal combustion engine is in a specific state, The identified parameter according to the output and the parameter-identification means 108 of the air-fuel-ratio sensor 100 for it being detected by the specific state detection means 107 that an internal combustion engine is not in a specific state, and cooking is used. by the fuel behavior simulation means 105 With the amendment fuel-oil-consumption amendment means 106, shell composition of the fuel quantity determined by the fuel-oil-consumption operation means 103 based on the calculated fuel quantity in an anticipation cylinder is carried out.

[Function]

Thus, in the fuel-oil-consumption control unit of the constituted internal combustion engine, while the suitable fuel oil consumption for controlling the air-fuel ratio of exhaust gas by the reverse model of fuel dynamic characteristics to a predetermined value is defined, fuel oil consumption is amended according to change of the property of an internal combustion engine, and control is maintained stably.

[Example]

(1) Composition of an example A view 2 is drawing showing one example of the fuel-oil-consumption control unit of the internal combustion engine concerning this invention. In the view 2, the air flow meter 3 is installed in the inhalation-of-air path 2 of an internal combustion engine 1. An air flow meter 3 outputs the electrical signal which is a device for measuring the air content which an internal combustion engine inhales, and is proportional to the volumetric flow rate of inhalation air. This electrical signal is supplied to A/D converter 1001 of a control circuit 10.

The degree sensor 6 of crank angle which converts into the degree sensor 5 of crank angle and the degree of crank angle which convert into the degree of crank angle and output a pulse signal every 720 degrees, and outputs a pulse every 30 degrees is attached in the distributor 4. The pulse output of the degree sensor of crank angle is supplied to the input/output interface 1002 of a control circuit 10.

Moreover, from an exhaust manifold 11, the air-fuel ratio sensor 14 is installed in the down-stream exhaust pipe 13, the voltage according to the oxygen density in exhaust gas is outputted to it, and A/D converter 1001 is supplied.

A control circuit 10 consists of for example, microcomputer systems, and contains A/D converter 1001, an input/output interface 1002, CPU1003, ROM1004 and RAM1005, backup RAM 1006, and clock generation circuit 1007 grade.

Moreover, the idle switch 16 for full open detecting [a throttle valve 15] whether it is no is formed in the throttle valve 15 currently installed in the inhalation-of-air path 2, and this output is inputted into a control circuit 10 through an input/output interface 1002.

Moreover, in a control circuit 10, the down counter 1008, a flip-flop 1009, and the drive circuit 1010 are for controlling an injector 7. That is, if fuel oil consumption calculates, the result of an operation will be set as the down counter 1008, and a flip-flop 1009 will also be simultaneously made into a set state.

As a result, the drive circuit 1010 energizes an injector 7.

When the down counter 1008 starts counting of a clock pulse (not shown) and the value of the down counter 1008 becomes zero, a flip-flop 1009 is reset and the drive circuit 1010 stops energization of a fuel injection valve.

That is, an injector 7 is energized only for the period calculated by fuel-oil-consumption control means, and the fuel according to the result of an operation is supplied to each cylinder of an internal combustion engine 1.

(2) Design of a fuel-oil-consumption control unit The point which should be taken into consideration since control precision constitutes the control unit which can perform stable high and control is as follows.

That is, all the fuel injected from the injector 7 is not poured in into a cylinder, but adheres to an inlet-pipe wall surface in part.

For this reason, even if it determines the injection quantity from an injector 7 that the air-fuel ratio of exhaust gas will serve as a predetermined value, a predetermined air-fuel ratio does not become.

moreover, that the dynamic characteristics of an internal combustion engine is with time or fuel -- it changes with change of a character

the above-mentioned point -- taking into consideration -- the dynamic characteristics of the fuel near the inlet valve -- taking into consideration -- fuel oil consumption -- determining -- change of dynamic characteristics -- detecting -- fuel oil consumption -- an amendment -- a control unit is constituted like

1) Construction of the dynamic model (internal model) of fuel In order to obtain the mass balance of the fuel near the injector, the imagination control volume valve flow coefficient near [as shown in a view 3] the injector is considered. It is k about the index showing the predetermined degree of crank angle (cycle). It is fi (k) about the fuel flow which flows into the predetermined degree k of crank angle (cycle) at valve flow coefficient.
It is fw (k) about the fuel quantity which has adhered to the wall surface at the predetermined degree k of crank angle (cycle).
It is fc (k) about the fuel flow which valve flow coefficient ****** to the predetermined degree k of crank angle (cycle).
It is R about the rate which adheres to a wall surface among the inflow fuel flow fi (k). It is P about the rate which remains on a wall surface among the wall surface adhesion fuel quantity fw (k). deltaf, then the following formula are materialized in the error accompanying modeling.
fw(k+1) =P-fw (k)
+ R-fi(k)-deltaf (1)
fc (k) = (1-P), fw (k)
+ (1-R) -fi(k)+deltaf (2)
In addition, (2) formulas constitute the fuel behavior simulation means 105 of a view 1.
2) Construction of the control system by the internal model and the reverse model A view 4 shows the basic composition of the adaptive control system constituted using the internal model and the control unit.
It is G about the equivalent transfer function of a control unit. It is H about the equivalent transfer function of an internal model. It is P about the equivalent transfer function of an actual internal combustion engine. It is fcro about the fuel quantity in a criteria target cylinder. It is fcr about the fuel quantity in a target cylinder. It is fc about the actual charge of cylinder internal combustion. It is fcm about the fuel quantity in a cylinder calculated from the internal model. If the error of the actual fuel quantity fc in a cylinder and

$$f c = \frac{G P}{1 - G H + G P} f c r \qquad (3)$$

$$\delta f = \frac{f c - G H f c r o}{1 - G H} \qquad (4)$$

It ******. Therefore, it is from (3) formulas. HG=1 (5)
If come out and it is (i.e., if a control unit is the reverse model of an internal model) fcro=fc (6)
It is not based on the dynamic characteristics of a next door and an internal combustion engine, but the fuel quantity fc in a cylinder becomes equal to the fuel quantity fcro in a criteria target cylinder.
Moreover, when an error arises from a ** (4) formula between fc and fcro at the time of HG=1, a bird clapper turns out that control is unstable with the value of deltaf having become infinite and having mentioned above.
That is, if the control system shown in the 4th view is constituted, it will become possible to control the air-fuel ratio lambda of exhaust gas to target air-fuel ratio lambdar.
3) Operation of the fuel quantity fcro in a criteria target cylinder The fuel quantity fcro in a criteria target cylinder which should be injected into each cylinder can calculate lambdar and an inhalation air content for a predetermined exhaust gas air-fuel ratio from mc (k), then the following formula.
Fcro=lambda r-mc (k) (7)
The air flow rate mc (k) which flows into each cylinder here can be calculated by which the following method.
(a) Compute by the ****** (8) formula.
mc(k) = (beta1 and Ne-Pm-beta 2, Ne) / Ti (8)
However, Ne= internal combustion engine rotational frequency Pm= pressure-of-induction-pipe force Ti= intake-air temperature A basic inhalation air content is calculated from the map which makes a parameter beta and alpha= (constant b) MAP Pm and the internal combustion engine rotational frequency Ne, it amends with an intake-air temperature Ti, and mc (k) is calculated.
(c) Presume from the detection value of an air flow meter 3.
That is, a ** (7) formula and the above (a), (b) or, and (c) constitutes a part of fuel quantity operation means (102) in a criteria target cylinder of a view 1.
(4) Construction of a feedforward control system It sets to the control system shown in a view 4, and is amendment fuel quantity. deltaf=fc(k)-fcm (k) (9)

However, although it becomes the fuel quantity in a model cylinder computed from the interior model of fcm=, since the fuel quantity fc in a cylinder (k) is directly immeasurable, it will ask according to an operation from Output lambda and the inhalation air content mc (k) of the air-fuel ratio sensor 14.
However, since the flow delay of exhaust gas and detection delay peculiar to a sensor are included in measurement of an air-fuel ratio lambda, it becomes fc!=fcro, and a ** (9) formula becomes unstable so that clearly also from (4) formulas.
In order to remove this trouble, these people have proposed the control unit which determines the amendment fuel quantity which carries out feedforward control from the amount of operational status of an internal combustion engine (Japanese Patent Application No. 1-54420).
therefore, this invention -- also setting -- for example, delta f=delta o-fw -- (k {Pm(k)-Pm (k-1)})
However, deltao= proportionality coefficient (10)
It shall carry out and the amendment fuel quantity which carries out feedforward shall be determined.
That is, the remaining portion of the fuel quantity operation means (102) in a criteria target cylinder of the 1st view consists of ** (10) formulas.
Therefore, fuel quantity fcr in a target cylinder Fcr=fcro+deltaf (11)
It is alike and, therefore, calculates.
5) Determination of fuel oil consumption The basic fuel flow fio (k) which should be injected from an injector 7 if fw (k) which becomes settled from (1) formula is used is fio[from (2) formulas] (k) ={fcr- (1-P) and fw (k)}/(1-R). (12)
It can ask by carrying out.
That is, (12) formulas constitute the fuel-oil-consumption operation means 103 of a view 1.
6) Amendment of fuel oil consumption Fuel quantity actually poured in into a cylinder Fi=fio+deltaf (13)
Then, the following formula is materialized.
deltafc(k) = P-delta fc (k-1)
+ (1-R) -deltafi (k-d +1)
+ (R-P) -deltafi (k-d) (14)
It is here. y(k) =deltafc (k)
u(k) =deltafi (k-d)
x(k) =y(k)-(1-R) -u (k)
P=Po+deltaP R=Ro+deltaR Po and Ro obtain the steady-state value, then the following formula of each parameter.
x(k+1) =Po-x (k)
+ Ro-(1-Po) -u (k)
+w1 (15)
y(k) =x(k)+ (1-Ro) and u(k)+w2 (16)
w1 and w2 are the function of delta P and delta R here. xs and us shall satisfy the following formula further.
xs=Po-xs+Ro -(1-Po)- us+w1 (17)
ys=xs+ (1-Ro) and us+w2 (18)
Furthermore, a variable is changed like the following formula.
x(k) '=x(k)-xs y(k) '=y(k)-ys u(k) '=u(k)-us deltax(k) '=x(k) '-x(k-1) ' deltax(k) '=u(k) '-u(k-1) ' (19)
Consequently, ** (17) and (18) formula indicates by the state variable like the following formula.

$$\begin{bmatrix} \Delta x(k+1)' \\ y(k)' \end{bmatrix} = \begin{bmatrix} Po & 0 \\ 1 & 1 \end{bmatrix} \cdot \begin{bmatrix} \Delta x(k)' \\ y(k-1)' \end{bmatrix} + \begin{bmatrix} Ro \cdot (1-Po) \\ 1-Ro \end{bmatrix} \cdot \Delta u(k)' \qquad (20)$$

The following formula will be obtained if the optimal regulator shown in 127 pages of a basic system theory (work besides Katsuhisa Furuta, Corona Publishing Co., Ltd. **) from 114 pages is designed as opposed to the system

expressed with a ** (20) formula.
deltau (k) ' =-f1, deltax(k) '-f2, and y(k-1) ' (21)
f1 and f2 are the optimal gain here.
The following formula will be obtained if it returns based on a variable.

$$\Delta fi(k) = \{-f1 \cdot \Delta fc(k+d) - f2 \cdot \sum_{j=1}^{k-1} \Delta fc(j+d) + wPR\} / \{1 - f1 \cdot (1-Ro)\} \quad (22)$$

wPR is the correction term of a parameter here. Since the value of the future is included in a ** (22) formula about deltafc, it replaces using a ** (14) formula.

$$\Delta fc(k+1) = P \cdot \Delta fc(k) + (1-R) \cdot \Delta fi(k-d+2) + (R-P) \cdot \Delta fi(k-d+1)$$

$$\Delta fc(k+2) = P \cdot \Delta fc(k+1) + (1-R) \cdot \Delta fi(k-d+3) + (R-P) \cdot \Delta fi(k-d+2)$$

$$\vdots$$

$$\Delta fc(k+d) = P \cdot \Delta fc(k+d-1) + (1-R) \cdot \Delta fi(k-1) + (R-P) \cdot \Delta fi(k) \quad (23)$$

Namely, a ** (14) formula

By substituting the above-mentioned formula one by one, it becomes possible to calculate the value of the future about deltafc from a known value. In addition, (22) and (23) formulas constitute the fuel-oil-consumption amendment means 106 of a view 1.
7) Identification of a parameter Although it came noting that the parameter in the model which expresses the dynamic characteristics of fuel in the above explanation was known, since it changes according to the operational status of an internal combustion engine in fact, a parameter is identified serially.
As this parameter-identification method, the method (Japanese Patent Application No. 2-193806) which these people proposed, for example can be used.
That is, only a known rate precesses fuel oil consumption and it is from the air-fuel ratio detection value at that time.
epsilon(k) =fcr(k)-fc (k) (24)
It carries out, and parameter P-R is determined using a well-known least-squares method so that the following performance index may take the minimum value.

$$J = \sum_{i=k-h}^{i=k} \varepsilon(i)^2 \qquad (25)$$

The number of time steps used for h= identification here In addition, (24) and (25) formulas constitute the parameter-identification means 108 of a view 1.
(3) Execution of control The functional diagram of the control unit constituted by the view 5 according to the above explanation is shown.
That is, in 501, the fuel quantity fcro in a criteria target cylinder calculates based on the internal combustion engine rotational frequency Ne and the pressure-of-induction-pipe force Pm by the method of of (a), (b) or, and (c) of a publication to a ** (7) formula and 3.
In 502, amendment fuel quantity deltaf calculates based on the internal combustion engine rotational frequency Ne and the pressure-of-induction-pipe force Pm by the ** (11) formula simultaneously.
The result of an operation in 501 and 502 is added, and it is led to the reverse model 503.
The criteria fuel oil consumption fio injected from an injector 7 based on a ** (12) formula in 503 is determined.
Based on this criteria fuel oil consumption fio, the fuel quantity fcm in a model cylinder calculates from a fuel dynamic model using a ** (2) formula by 504.
Based on the fuel quantity fc in a cylinder of an actual internal combustion engine, and the fuel quantity fcm in a model cylinder, amount of fuel-oil-consumption amendments deltafi is calculated using ** (21) and (22) formulas by 505.
This amount of fuel-oil-consumption amendments deltafi and criteria fuel oil consumption fio calculated by 503 are added, and it becomes the fuel oil consumption fi actually supplied to an internal combustion engine.
Furthermore based on this fuel oil consumption fi and the fuel quantity fc in a cylinder of an internal combustion engine, the parameter of a fuel dynamic model is identified in 505 using ** (24) and (25) formulas.
A view 6 is a routine for performing control by this invention, for example, is performed for every stroke.
That is, the detection value Ne required for execution of this routine at Step 601, i.e., an internal combustion engine rotational frequency, the pressure-of-induction-pipe force Pm, and the air-fuel ratio lambda of exhaust gas are read.
In Step 602, the fuel quantity fcro in a criteria target cylinder and amendment fuel quantity deltaf calculate.
And in Step 603, it is judged whether an internal combustion engine is in an idling state.
It is detectable whether it is in an idling state whether an idle switch 16 is ON. In addition, Step 603 constitutes the property state detection means 107 of a view 1.
Usually, when it is operational status, a negative judging is carried out at Step 603, and it progresses to Step 604.
In Step 604, criteria fuel oil consumption is calculated using a reverse model.
The amount of fuel-injection amendments calculates in Step 605, and it is added with criteria fuel oil consumption in Step 606.
And let the time injector 7 with which the fuel quantity defined at Step 606 in Step 607 is injected be open.
When an internal combustion engine is in an idling state, in order to carry out an affirmation judging at Step 603 and to identify the parameter of a fuel dynamic model, it progresses to Step 608.
In Step 608, the regularity rate perturbation of the fuel oil consumption is carried out, and fuel is injected from an injector 7 at Step 609.
The parameters P and R of a dynamic model are identified at Step 610, and renewal of a parameter is performed at Step 611.
[Effect of the Invention]
change of the property of the fuel-injection control which was excellent in responsibility combining the reverse model and fuel dynamic model of fuel dynamic characteristics being not only realizable according to the fuel-injection control unit of the internal combustion engine by this invention but an internal combustion engine -- responding -- fuel oil consumption -- an amendment -- it becomes possible to increase the stability of control by things

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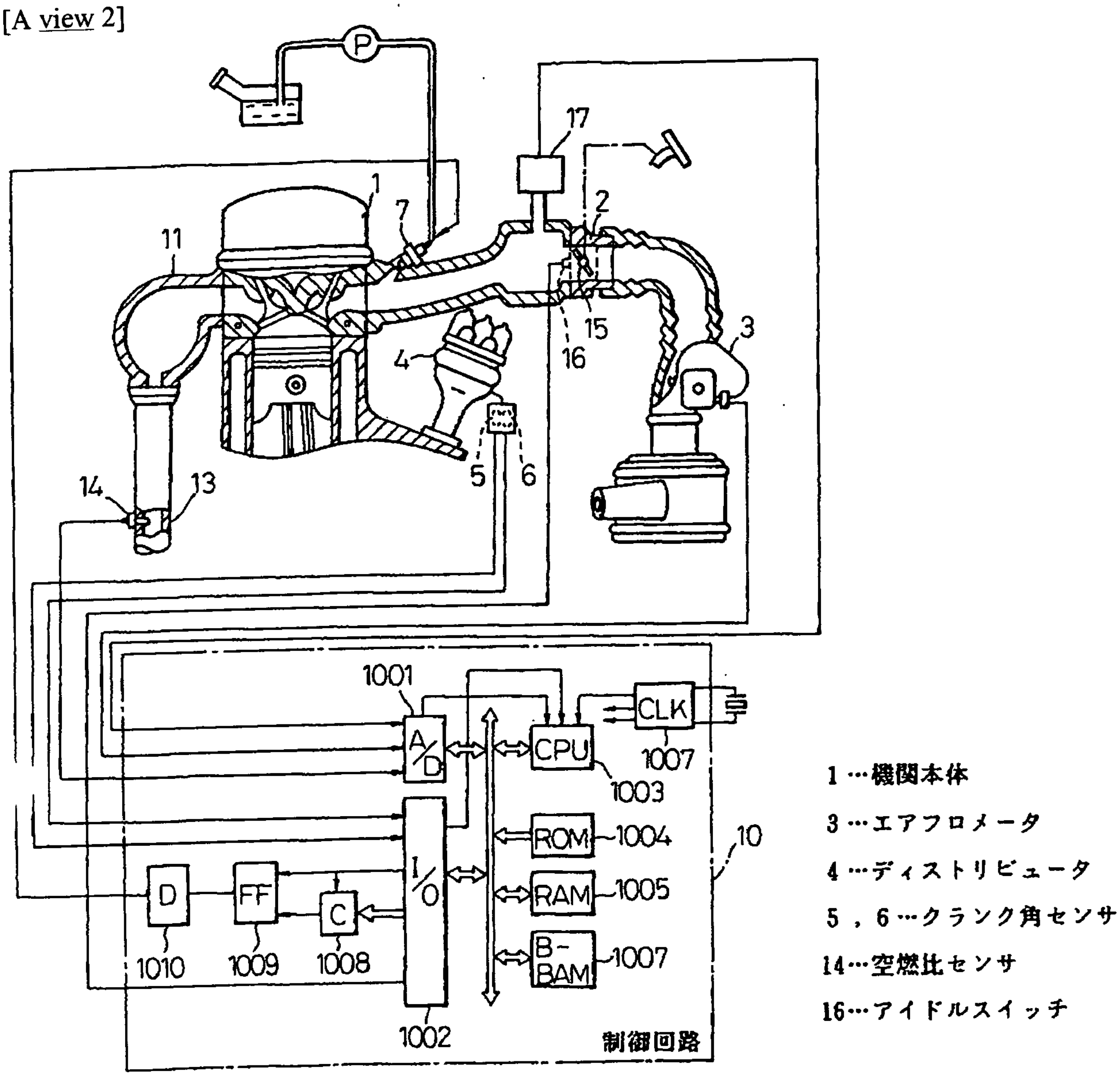
[Translation done.]

* NOTICES *

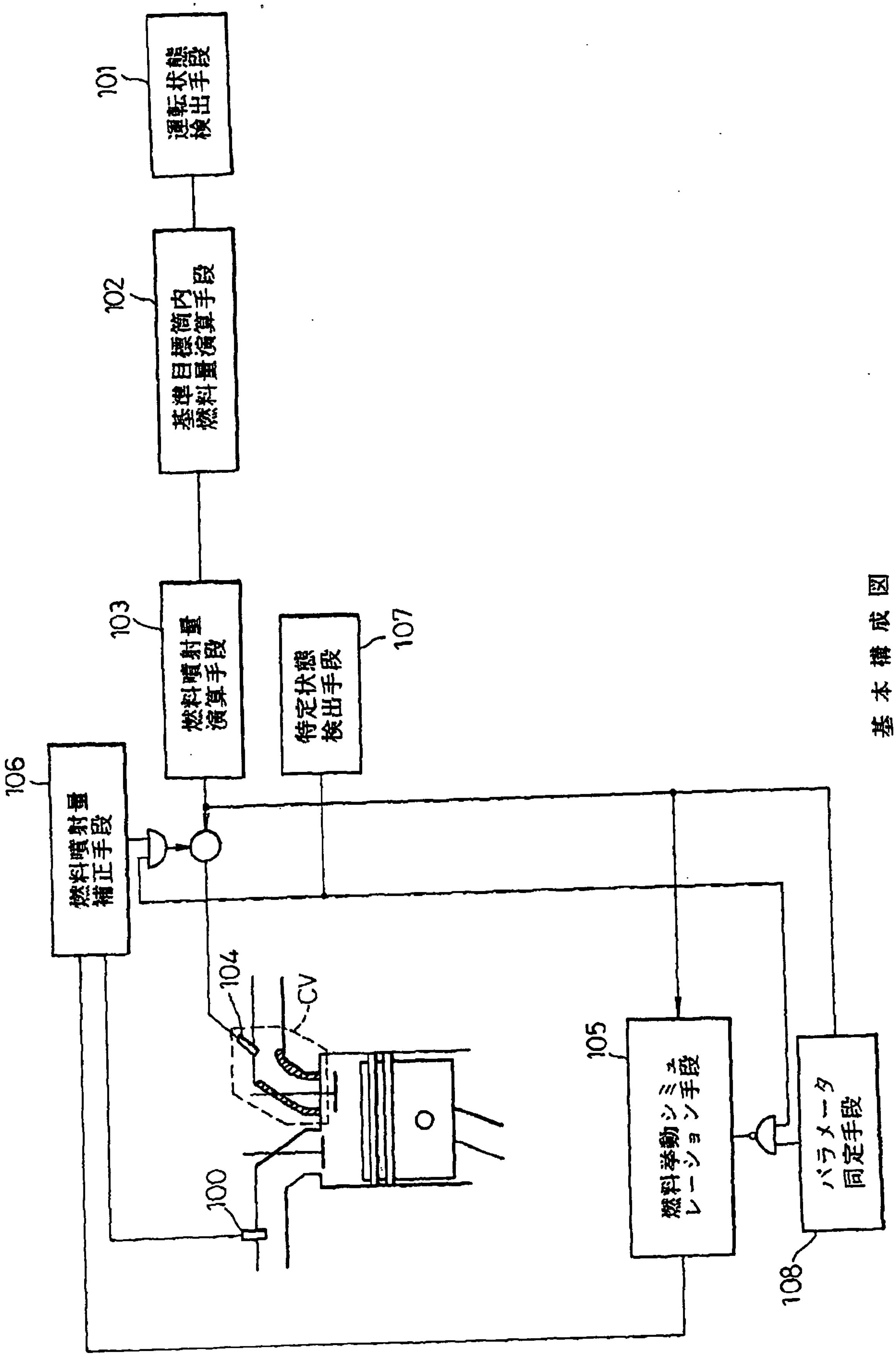
DRAWINGS

[A view 2]

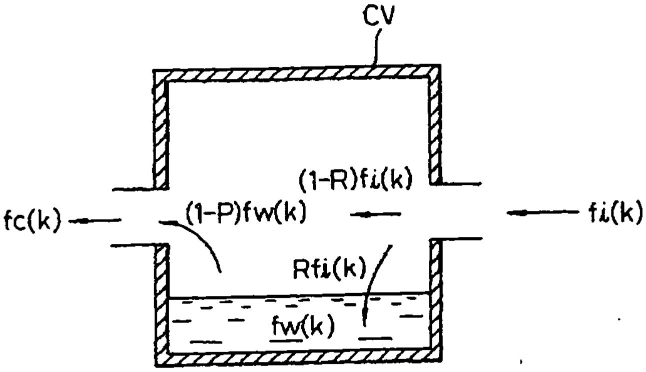


実 施 例

[A view 1]

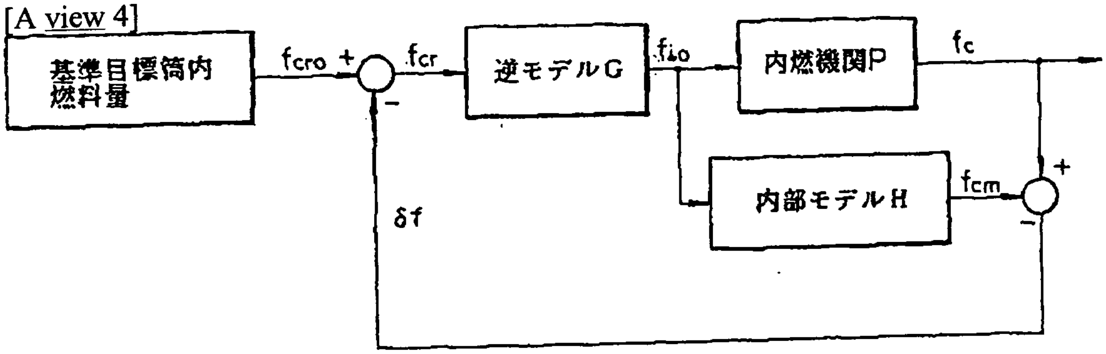

101
運転状態検出手段
102
基準目標筒内燃料量演算手段
103
燃料噴射量演算手段
107
特定状態検出手段
106
燃料噴射量補正手段
104
CV
100
105
燃料挙動シミュレーション手段
108
パラメータ同定手段
基本構成図

[A view 3]



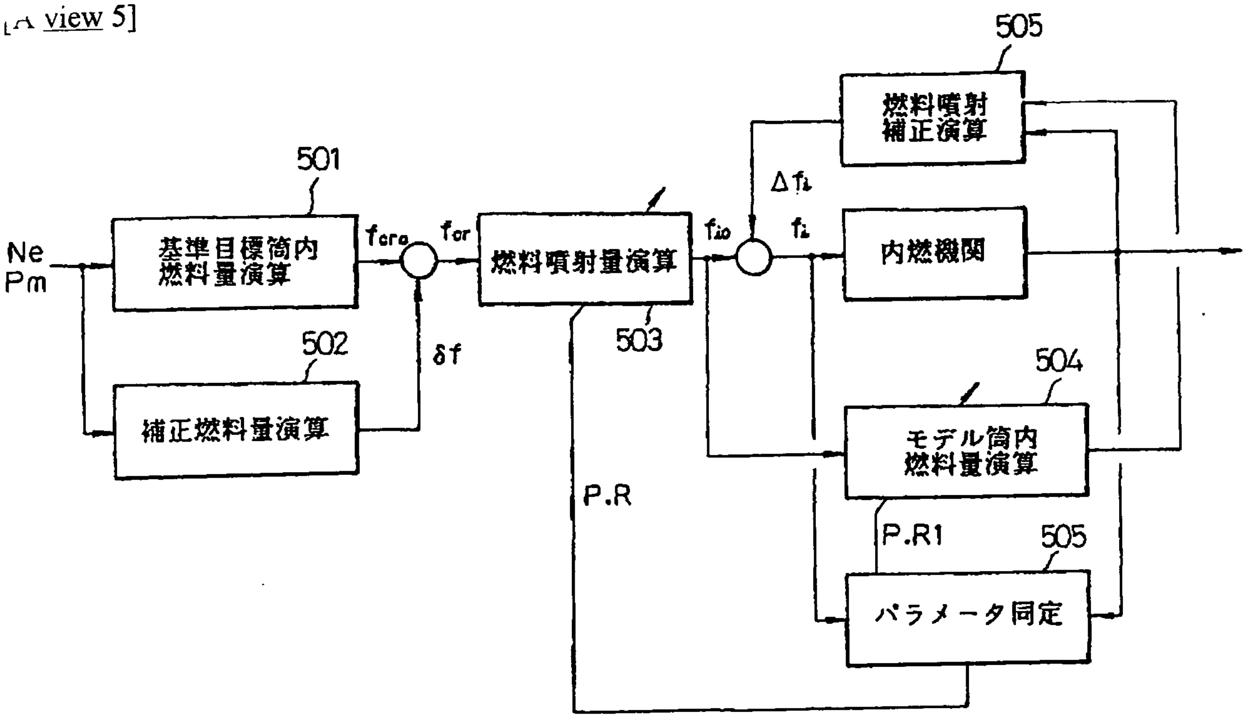
燃料の動的挙動を表すモデル

[A view 4]



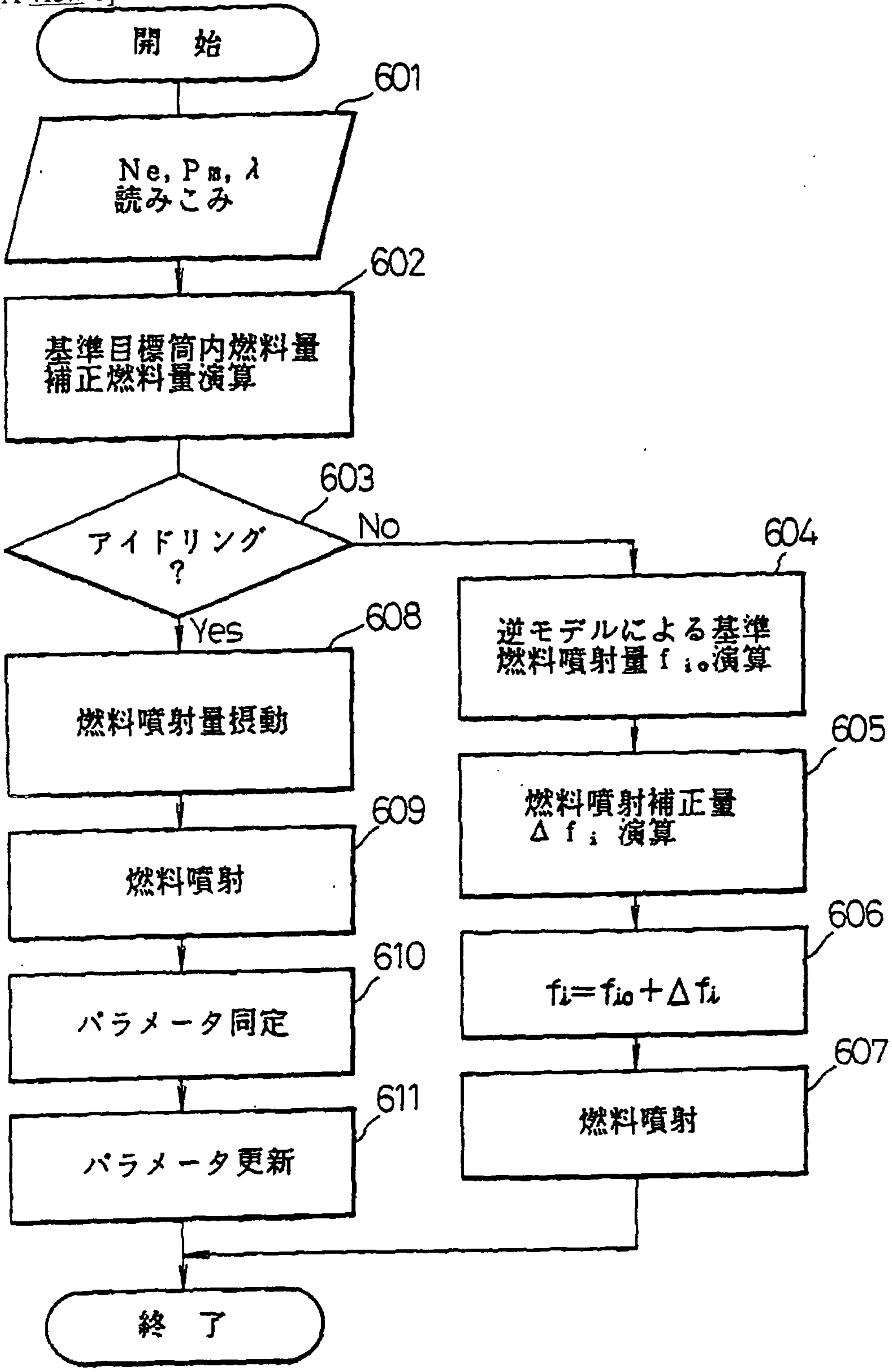
逆モデルと内部モデルによる制御系構成図

[A view 5]



制御機能線図

[A view 6]



制御演算フローチャート

[Translation done.]